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Section B
BIOLOGY and GEOLOGY

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THE IMPROVEMENT OF THE AWASSI BREED OF SHEEP IN ISRAEL

M. Finci

CONTENTS

THE IMPROVEMENT OF THE AWASSI BREED OF SHEEP IN ISRAEL

M. Finci

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ABSTRACT

The Awassi breed of sheep, the Improved Awassi in Israel and their environmental conditions are described. Data on reproduction are given. Concentration of lambing and the reduction of late lambings are discussed. Regional differences found to exist in twinning indicated that grain fodder fed before the mating season, has a great influence both on increase in twinning and on concentration of lambing. Studies on the recurrence of twinning pointed to the influence of genetic factors. The influence of age on twinning is discussed. A tendency to improve precocity was noted.

The methods used for, and the results obtained in, the improvement of milk production are described. The course of lactation in 30-day intervals is given. The influence of age on milk production has been investigated and the age correction factors are stated. Intensity of production has been shown to be more important than its duration. Repeatability of milk yields has been examined, and indications have been found that selection could be based on first lactation yield.

Possibilities of meat production are discussed, and improvement obtained in body development of adult ewes in some of the best flocks has been noted.

Wool production has been studied in one of the best flocks, and it has been shown that increase in fleece weight is not incompatible with high milk yield.

I. INTRODUCTION

It is generally estimated that the Awassi sheep produces an average of about 40 kg of milk per year, besides the milk sucked by the lamb. If we allow 50% of this amount for suckling, we may estimate the average annual milk production of a milking Awassi ewe at about 60 kg.

The Improved Awassi, bred in Israel, had in the 1955—56 milking season an average of 280 kg of milk, calculated from 22,519 recorded ewes belonging to 109 flocks and registered in the Awassi Flock Book. This average figure includes the milk sucked by the lamb. The improvement is even more marked if we take into consideration that in the same year the best flock in Israel, that of Ginegar, had an average yield of 452 kg of milk from 276 ewes.

This improvement is the result of the combined and persistent efforts made by the sheep-breeders ever since this agricultural branch was introduced in the cooperative settlements based on mixed farming.

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Some of the milestones in sheep-breeding activities will illustrate the gradual improvement of the local Awassi sheep:

1924 — The first annual meeting of Jewish sheep-breeders at 'Ein Harod.

1929 — The Jewish Sheep-Breeders' Association established at the Annual Assembly at Tel Yosef.

1932 — The Annual Assembly at Kfar Gil'adi formulates its "breeding aim" to be "the improvement of milk and mutton production in sheep". Uniform milk recording and bookkeeping in the flocks adopted.

1935 — "Controlled service" for mating introduced in the better flocks.

1936 — The first book on sheep-breeding (by S. Hirsch) published by the agricultural journal *Hassadeh.*

1937 — The Annual Assembly at Kfar Hahoresh considers the introduction of cross-breeding with imported milk breeds of sheep, but this proposal was rejected. The breeding aim modified as follows: "... the increase of milk production by taking care to preserve the robust and healthy constitution of the Awassi breed of sheep".

A detailed working plan adopted by introducing the following measures:

(a) Milk recording to be carried out every 14 days by weighing instead of measuring.

(b) Standardization of all milk records by including an estimate of the milk suckled by the lamb in order to obtain the milk production for the ewe's entire lactation period.

(c) All records to be kept in a card system instead of in books.

1940 — Publication of the professional organ of the Sheep-breeders' Association, *Hanoked.*

1941 — "Progeny tests" of the rams of the 'Ein Harod flock started, tracing the ram "Aizik", progenitor of a number of excellent rams and ewes.

1943 — Establishment of the Flock Book for the Improved Awassi, with the minimum milk production of 250 kg required for the registration of a ewe. This minimum was raised to 275 kg in 1948—49, and to 350 kg in 1955—56.

1944 — The first Sheep-breeding Exhibition was held in Kfar Yeladim.

1948 — The book on sheep-breeding by D. Becker published by the Sheep-breeders' Association.

1950 — Introduction of Ram Certificates for every ram active in the flocks, giving all available data, for evaluation for breeding purposes.

1951 — Introduction of Flock Files by the Flock Book management, giving for each flock all the data available about its development and breeding standard.

1952 — The first milking machine for sheep imported for experimental purposes by the Sheep-breeders' Association.

1955 — The "revolving platform" for machine milking, with a capacity of 128, planned by A. Aloni ('Ein Harod), was erected at Ramat Hashofet by the Sheep-breeders' Association with a subsidy from the Ministry of Agriculture and U.S.O.M. Joint Fund.

The purpose of the present investigation is to use the Flock Book data, consisting of about 10,000 individual cards, for an analysis of the performance of the Awassi. Four flocks from different parts of the country were chosen, but where necessary other flocks were included in order to obtain sufficient data.

It should be pointed out, however, that we are dealing here with a breed which is kept in larger flocks of about 250—500 milking ewes. Some other breeds, such as the Ostfrisian milch sheep or the Italian Langhe sheep, are usually kept in small flocks of 5—6 milking ewes. In these breeds, due to the small number of animals, an almost individual treatment can be applied to each ewe, whereas in the larger flocks such individual treatment is impracticable, especially with regard to feeding and general management.

II. THE AWASSI BREED OF SHEEP

1. *Origin*

The Awassi belongs to the large group of fat tailed sheep which are prominent in the sheep population of Asia and Africa. We find records of fat tailed sheep already in old Assyrian monuments as reproduced by Kronacher [12], representing the booty captured at a Jewish town at the time of Tiglat-Pilesser (745 B.C.), as well as detailed descriptions of the fat tailed sheep in Arabia by Herodotus (500 B.C.).

2. *Distribution*

The Awassi is also found in the neighbouring Arab countries (Transjordan, Syria, Lebanon and Iraq); there are small numbers in the southern part of Turkey, where on one occasion the author found, in the market of Urfa, typical Awassi called "Arab sheep" or "Iwessi sheep". The name is supposed to be that of the Beduin tribe "Awass", which lives in the Euphrates region.

3. *Description*

The typical Awassi is white woolled with brown head and legs, and large drooping ears. The females are mostly hornless, whilst the rams are mostly horned. The brown colour of the head is often broken by white markings, which may be small, such as a star on the forehead, or fairly large, covering the whole profile part of the head. The intensity of the brown colour varies from light to very dark brown. Besides these typical markings, there are also sheep with black, grey, white and spotted heads and legs. Sometimes the wool is also brown, or has large brown regions. Black woolled sheep occur occasionally.

The fat tail is large, particularly in animals in good bodily condition, and has a peculiar shape, differing from the other closely related fat tailed sheep. It starts with a broad fat cushion, which narrows and turns upwards, ending in a thin part hanging down.

Details on body conformation are given below.

4. *Characteristics*

The Awassi is a healthy and strong sheep, wholly acclimatized to the natural conditions of the region and capable of enduring the intense summer heat as well as the heavy winter rainfalls. It is a good grazing animal, able to utilize even the driest pastures.

It is clear, however, that under primitive conditions, without shelter and supplementary food, its economic performance must be poor. In drought years, when grazing is poor and the condition of the flock lowered, mortality may be as high as 50% (Hirsch, 1933).

5. *Economic performance*

The Awassi is kept for milk, mutton and wool production. The performance of this breed in Syria and Palestine is described by S. Hirsch (1932, 1933). He writes on the Palestinian Awassi: "The Awassi sheep is not primarily a wool producer; its chief products are flesh and fat, while milk also plays an important part. The milk production of the Awassi sheep is very variable. According to the monthly records kept in Merhavia during this year (1932), the annual milk yield of a ewe, apart from the quantity consumed by the lamb, was 30—150 litres, the average being 63.5 litres. However, the conditions were very favourable." He concluded that "the average annual yield, when calculated for the whole country, cannot be reckoned higher than 40 litres per ewe".

D. Sayeg (1949) stated about the Awassi, which predominate in the Lebanon, that a ewe gives an average of 500 gr milk per day and in rich regions even 1 kg.

K. Bilgemre (1949) claims that the Karaman sheep, which generally yield 25 kg of milk, give 50—65 kg with good food and management. He wrote later that the Iwessi sheep give more milk than the Karamans, and in a private communication estimated the milk production of the Iwessi sheep of Turkey at 40 kg per year, in addition to the milk consumed by the lamb. Bilgemre also gave the following information on the milk yield of Turkish sheep, according to a study of large animal stocks (Table I).

These data are particularly interesting for this study, because sheep are kept in Turkey in precisely the same way as in the neighbouring Arab countries where Awassi are bred. We see that the estimated milk yield for the breed as such — when stock is kept under primitive conditions, with little or no shelter and with only occasional supplementary feeding — can be estimated at 40 kg of milk, apart from the milk consumed by the lamb.

TABLE I
Milk yield of Turkish sheep

Breed	Yield in kg
Red fat tail (Red Karaman)	30
White fat tail (White Karaman)	25
Karakul	30
Chios sheep	80
Kara-Yaka	30
Kivircik	40
Merinos (wool and meat type)	25

Such stock responds favourably to the change in the environmental conditions, following the purchase from Arab owned flocks and the transfer to an advanced farm in Israel, into a sheep shed provided with the equipment necessary for feeding, watering and milking, and given supplementary food to keep them in fairly good bodily condition throughout the year.

Table II gives the average milk production of Awassi acquired in 1948 from various Arab flocks. They were kept in four separate flocks, and the milk recording was started at their first milking season with the Jewish flocks. The length of the preparatory period was about eight months, and the sheep were in the meantime served by rams bred in the advanced flocks.

TABLE II

The milk yield of unimproved Awassi sheep kept under better environmental conditions

The first milk recording in flocks acquired in 1948: Megiddo, Rosh Hanikra, Yassour and Hahotrim

Ewes under milk control	Milk yield M. kg	S.E. kg	S.D. kg	Max. milk yield kg	Ewes with milk yields above 250 kg No.	%
402	129.13	2.3088	46.291	320	6	1.50

The improved environmental conditions resulted in an average milk yield of more than double the average estimated for the breed (60 kg including the quantity suckled by the lamb). More important for the prospects of selection is the fact that 25 ewes (6.22% of the total) yielded over 200 kg of milk, including 4 ewes with over 250 kg and 2 ewes exceeding 300 kg, the maximum being 320 kg.

It must be pointed out that care is taken to purchase only healthy sheep, up to four years old and in good condition. Exceptionally good sheep with well developed udders, bought from Arab flocks and transferred to some of the best flocks, have been known to yield 350—400 kg of milk. This is surely a clear sign that the Awassi has a high milk producing capacity, a fact which encouraged the entire selection programme.

6. *Mutton production*

Hirsch (1933) gives the following birth weights:

Ewe lambs	4.28 kg
Ram lambs	4.63 kg

He continues: "The lambs grow fairly fast, and when weaned at the age of two months they weigh about 20 kg. Ram lambs, generally sold for slaughter at the age of two months, vary in weight from 15 kg to 25 kg." Concerning the weight of adult animals, he states: "At the shearing season the weight of a mature ewe is 30—50 kg, with an average of 40 kg. The weight of yearlings is 25—40 kg, with an average of 32 kg. The weight of a mature ram is 60—90 kg, averaging 75 kg. These averages were arrived at after weighing 230 sheep and 22 rams of various ages belonging to both Jews and Arabs

in different parts of the country. It appeared that Jewish owned sheep were heavier than sheep belonging to Beduins and Fellahin; this can be accounted for by the careful selection and superior feeding and care given to flocks in Jewish settlements.

Average weights (with the wool) taken in April 1930 are given in Table III.

The slaughter weight of a fat mature sheep in the summer is 50—54% (average 52%) of the live weight; in the case of rams it is somewhat higher. The slaughter weight of 2-month old lambs is about 55% of the live weight."

TABLE III
Average weights of sheep in 1930

Settlements	Ewes		Rams	
	n	kg	n	kg
Beit Alpha	78	41.610	7	75.334
Tel Yosef	22	42.584	6	73.698
Kfar Giladi	16	40.659		

7. *Wool production*

We have for this item also the figures given by Hirsch (1933): "In single annual shearing the weight of the ewe's fleece is 1—2.5 kg (average 1.75 kg), that of the ram being 2—3 kg (average 2.25 kg)."

III. THE IMPROVED AWASSI SHEEP OF ISRAEL

8. *Numerical data*

The 1930 census of livestock in Palestine showed the number of sheep to be 252,773, that of goats 440,132 (Hirsch [7]) and nearly 250,000 heads of cattle; they all found the greatest part of their food requirements on natural pastures.

The 1944—45 census gave the following figures: 244,062 sheep, 325,376 goats and 242,945 cattle. Out of this number there were on the area which now forms Israel, the following grazing animals: 138,374 sheep, 187,730 goats and 146,631 cattle.

In Jewish settlements there were in 1931 (Hirsch, 1933) about 4,000 sheep and 3,000 goats (about 1% of the total in the country). This number increased to 19,000 sheep, kept in 76 Jewish owned flocks in 1948, just before the end of the British Mandate.

During the War of Independence the greatest part of the Arab owned sheep and goats were taken across the border, so that there remained approximately 20,000 sheep and 70,000 goats in Arab owned flocks in Israel.

The entire sheep population of Israel, at the time of the establishment of the State, amounted to only about 39,000.

At the beginning of 1956 the number of sheep in Jewish owned flocks was 100,000, an increase of over 400% in the period of eight years. This has been achieved partly by natural increase, by rearing the greatest possible number

of female lambs from year to year, and partly by large scale imports during 1953 and 1954, mainly from Turkey. A breed of fat tailed sheep, called Hirik, from the vicinity of Gizre on the Tigris, was chosen due to its outward resemblance to the Awassi kept in Israel.

The number of sheep and goats in the Arab owned flocks has remained stationary, as the natural increase mostly serves to replace animals slaughtered for consumption.

Of the total number of sheep in the country, only ewes yielding over 250 kg of milk and belonging to flocks practising milk recording, can be considered as Improved Awassi. In 1955—56 there were about 15,000 such ewes in Israel.

9. *Grazing possibilities*

In a country devoid of grazing animals to such an extent as Israel, there is abundant and rich pasture for sheep during the greater part of the year. The green natural pasture starts at about the end of January and begins to dry up during the second half of April, when the flocks graze on stubble fields following the harvests of barley and wheat. In the summer months, grazing is chiefly on dry grass in the natural pasture fields.

Nevertheless, there are about 2—3 months of the year when grazing is very scarce due to climatic conditions. This difficult time extends in years with normal rainfall from the beginning of November to the end of January. In years with good rainfall this period of scarce grazing is shortened to about two months: from the beginning of November to the beginning of January; the ewes are at this time in their last month of pregnancy, as lambing occurs from December to mid-February. Supplementary food must be given to enable the sheep to deliver and rear healthy lambs and to develop their milk production.

10. *The Israeli shepherd*

In this country with its strongly expressed pioneering spirit, a special type of agricultural worker has developed, particularly before World War II, due to the professional readjustment of immigrants. What they lack in agricultural tradition, they try hard to compensate by theoretical study and by an advanced approach to the particular work they perform. The young people, brought up in the country, mostly follow the same example, having in addition the benefit of agricultural work from their earliest days.

The man who has decided that sheep-breeding will be his life-long vocation, and who often speaks several languages, avidly follows anything published in this field abroad. Charged with the responsibility for the management and development of his branch in a cooperative settlement, he will generally do his best in order to increase the income of the branch and to achieve a high remuneration for each work day in the sheep fold. He develops, in due time, from a shepherd into a sheep-breeder, performing all routine work, such

as going to pasture, supplementary feeding, milking and tending. Some of them even memorize the ear numbers of each of several hundred ewes in a flock. This appears to be a particularly remarkable achievement in the better flocks where great efforts have been made in attaining external similarity of the animals, who look all alike to an outsider.

This aspect is dealt with at some length, as the author is convinced that a considerable part of the credit for the general improvement of the Awassi is to be attributed to the human factor. This is further substantiated by the evidence that the best flocks in the country are closely connected with the names of the shepherds in charge, whilst there also exist other flocks which did not improve during the past 15 years, due to the frequent changes in their management. In Israel as in other countries, the ability of the individual breeder is a precondition for the establishment of elite flocks.

11. *The cooperative settlement*

The types of agricultural settlements known in Israel as the Kibbutz, Kvutzah or Moshav Shitufi, based on cooperative work in the settlement and practising mixed farming, seem to be particularly well suited to successful sheep-breeding. The ownership of the 109 flocks registered in the Flock Book is distributed as shown in Table IV.

TABLE IV

Distribution of ownership of the 109 flocks registered in the Flock Book

Owner	Flocks
Cooperative settlements	99
Agricultural schools	6
Government experiment station	1
Private owners	3
Total	109

A spirit of cooperation prevails in the dealings between the individual settlements, particularly with regard to mutual support and advice, as well as in respect of the disposal of valuable breeding material. The settlements readily submit to the prices fixed beforehand by the Sheep-breeders Association, of which they all are members. The prices are fixed for adult sheep and for male and female lambs sold for breeding. The actual expenses involved in the raising of each type of animal are calculated. An allowance is then added according to the quality of the animal and excessive profits are neither sought nor permitted. Thus, even financially weak settlements are able to acquire valuable animals for further improvement of their flocks. The most important criterion for the distribution of rams is the breeding standard of the flock, as shown by the average of the milk yield of the last milking season. A steady improvement of each flock is assured: the best rams bred in the country go to the best existing flocks, to whom a medium quality ram might cause a decline in milk production.

12. *The Sheep-breeders Association*

The Association, on its foundation in 1929, had a membership of 16 shepherds working in the four flocks of Kfar Giladi, Ayelet Hashahar, Tel

Yosef and Beit Alpha, all cooperative settlements. At its 25th anniversary in 1954, there were nearly 2,000 shepherds to almost 400 flocks.

The Association is very active in all branches of sheep-breeding. The General Assembly meets once a year, discusses the reports and issues the necessary directives to the different committees; the most important of these committees are:

(a) Breeding problems.

(b) Health problems.

(c) Improvement of buildings.

(d) Professional publications.

(e) Cultural activities.

(f) Migration of flocks in emergencies.

Regional assemblies are convened prior to the beginning of the mating, lambing and shearing seasons, in order to promulgate the instructions necessary for field work.

Extension courses lasting about three weeks are arranged every year in co-operation with the Government both for beginners and for advanced shepherds.

The work is in this way divided among teams of experts who are responsible to the General Assembly for carrying out its instructions.

The Association owns the Flock Book, which is kept by the Chief of the Sheep-breeding Section in the Ministry of Agriculture, thus ensuring coordination in the work of all people directly interested in the development of the sheep industry in Israel.

IV. ENVIRONMENTAL CONDITIONS

13. General remarks

The environmental conditions under which the sheep are kept in the better flocks, i.e. those registered in the Flock Book, will be described here in a general way. The fact that a ewe cannot produce much milk if not given the necessary food at the right time, indicates the extent of feeding, care and management to be given to the flock. However, the rentability of a flock can easily be endangered by excessive expenses for supplementary feeding or labour, which are the main items involved.

The system of management of a cooperative farm greatly helps in establishing these two essentials. All, even the smallest, expenses in the sheep branch are duly debited, to which is added the branch's appropriate share of the general expenses of the settlement. The number of work days in the sheep branch is also recorded. Against this is credited all income from the sale of sheep and their products, including those used by the settlement. At the end of the financial

year the balance is divided by the total work days spent in this branch. Generally, when any branch shows, over a number of years, an average work day production falling below the average accepted in a particular settlement, then its future is discussed by all members and they may decide to dissolve this branch in their settlement.

The work day in all the better flocks is relatively highly productive. The most important factor in achieving this aim is the use of the natural pasture available on the farm and in its vicinity; this naturally appears on the expense side of the branch only in the form of work days. 70% of the total food requirements of a flock are not paid for; however, in a flock with a high standard of milk production, this may fall to as low as 50%, due to the necessarily more generous supplementary feeding during lactation.

14. *Supplementary feeding*

The food requirements are calculated by taking 0.7 F.U. (Feeding Unit) per adult ewe as maintenance fodder. The food requirement for the production of milk is calculated on the basis of the breeding standard of the flock; this gives a fairly good indication of its milk producing capacity. For each kg of milk 0.6 F.U. are taken into account. An allowance is made for pregnancy, and the number of feeding units for younger stock and rams is added.

To cover these requirements, natural pasture available to the flock is estimated and deducted. The rest has to be supplied by supplementary feeding, with due attention to the quantity of proteins needed for milk production and growth of lambs. The greatest part (65%) is given in the form of concentrated fodder. The remainder consists of hay, silage or green fodder.

It is seen from the foregoing that supplementary fodder is supplied rather abundantly; this allows the good milk producers to show up in the flock. As the feeding and all other expenses in a flock are exactly the same for the best and for the poorest ewe, the shepherd is interested to keep exact milk records which enable him to cull the poor producers endangering the rentability of the entire flock. The environmental conditions for all ewes in a given flock being equal, the high production of individual ewes indicates their capacity to be based on genetical factors.

15. *Rearing of lambs*

Lambs kept for breeding are weaned at the age of two months. They are not taken to pasture but receive sufficient quantities of green fodder, hay and concentrates. In the evening, with the return of the flock from pasture, the lambs are admitted to their mothers and stay with them for the night.

It became evident, with the general increase in milk production, that the lamb does not need all the milk produced by its dam. Some breeders introduced,

Figure 1
Sheep shed at Sarid

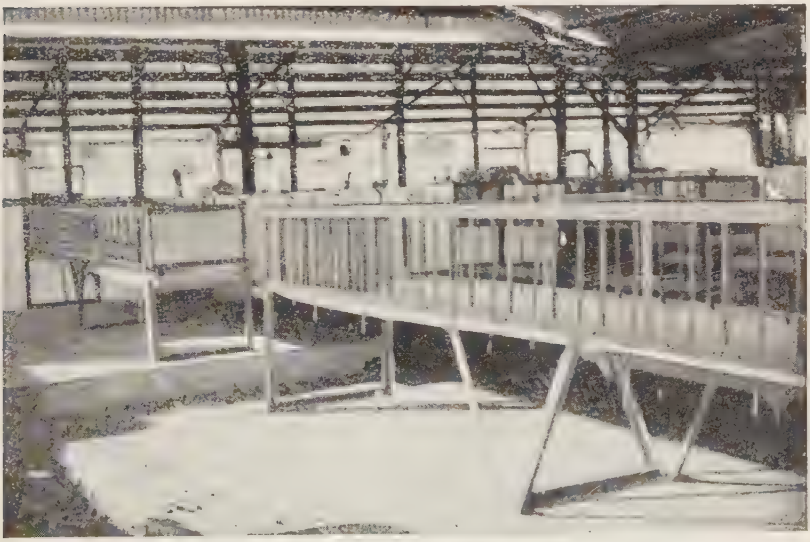


Figure 2
Milking room with milking stands for hand milking

Figure 3

Ewes trapped in milking stand at Ginegar

Figure 4

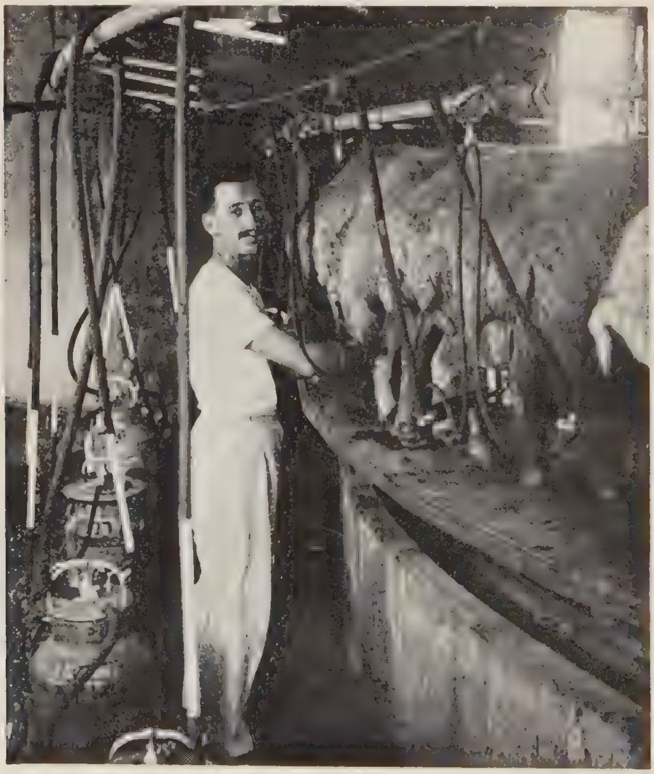
Hand milking at Ginegar

Figures 5 and 6

Revolving platform for machine milking at Ramat Hashofet. 128 ewes trapped in same way as in hand milking stands

Figures 7 and 8.

Revolving platform for machine milking at Ramat Hashofet. 128 ewes trapped in same way as in hand milking stands



therefore, a system of partial suckling in their flocks. In order to check this method, experiments were made, during two consecutive years, at the Government Stock Farm at Acre, with the aim to reduce the quantity of milk allowed to the lamb. As a result, "partial suckling" was introduced in the flocks, starting when the lamb is about 14 days old. The lamb is admitted to its dam only after she has been milked in the evening and remains with her for the night, i.e. 12—13 hours. The lambs weigh approximately 20 kg at weaning, showing that partial suckling was not detrimental to their development. After weaning, the lambs are taken to pasture and are supplied with supplementary food to ensure their proper development.

16. Housing conditions

The sheep shed is usually built for a flock of 350 heads, this being the accepted most efficient working unit as regards the number of shepherds involved. The inside arrangements are made chiefly from the labour saving point of view. The movable partiton fences and feeders allow the division of the shed into several parts, according to the needs of each particular season.

Milking stands are in a separate compartment. They look like feeders, but are made of iron, and when concentrated food is spread in them, the sheep run and occupy every available space, putting their heads through the iron bars from each side of the stand. By moving a handle they are all trapped by their necks, to be released when milking is over. The shepherd moves on a bench from one end of the line to the other and then returns to the first sheep to finish them off and to extract the rest of the milk left in the udder. Each stand provides space for 28 sheep; in this way milking can be finished in a relatively short time (vide Figures 1—4).

Machine milking was introduced experimentally in 1952 in two settlements and at the Government Stock Farm at Acre. The sheep had, however, to be finished by hand following the machine milking in order to extract the milk left in the udders. The extent of labour saving did not satisfy the breeders and they decided to build a revolving platform which would solve this problem more satisfactorily.

The first "revolving platform for machine milking", planned by A. Aloni of Ein Harod, was erected in 1955 by the Sheep-breeders' Association for the Ramat Hashofet flock, with a capacity of 128 ewes. Each time 16 ewes are brought before the milker, who performs his work standing up. This makes the milking much easier and enables even the older shepherds of the settlements to continue in their jobs. Despite the necessity to finish the milking by hand, the results were very satisfactory. Besides labour saving and hygienic milking—the milk flows from the udder directly into the closed milk container — it was observed to prevent the spread of mastitis in the flock.

The problem of employing machine milking also on milk recording days has, however, not yet been solved. At present, milk recording is done by hand milking, necessitating the availability of trained milkers in the settlement in order to help in this operation (vide Figures 5—8).

A further step in the improvement of this device has already been made at Ein Harod, which is now building a platform with a capacity of 224 ewes, 32 of whom will be milked simultaneously. The sheep will be placed head to head and the inner space of the platform circle will thus be better utilized.

The main gain from this device, under Israeli conditions, is, however, the fact that it will enable the settlements to keep much larger flocks, which was impossible until now because of the shortage of labour. When the flock grows in size, the shed is enlarged to add the necessary space, while most of the existing arrangements can be used for a larger flock. The space division in the shed is shown in the floor plan in Figure 9.

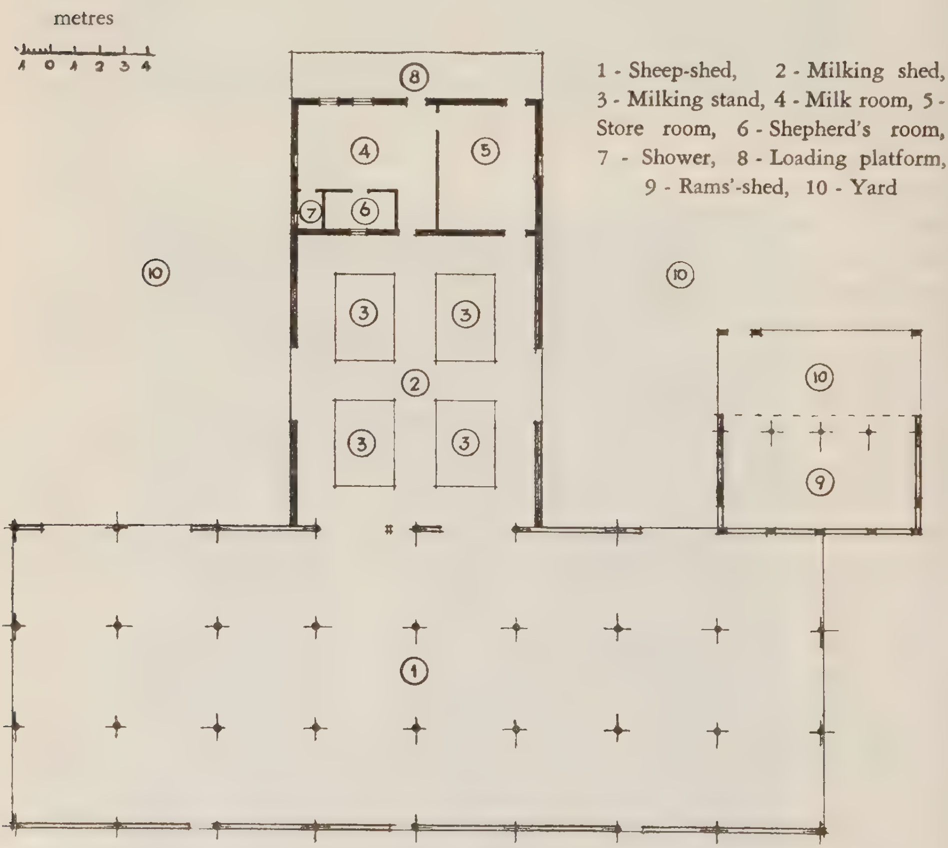


Figure 9

Sheep shed for 350 ewes — floor plan

17. *Labour conditions*

Labour accounts for over 50% of the general expenses and an excess of work days spent on the flock may undermine its rentability. A record is therefore kept of the work days according to the various jobs performed; the total is then divided by the number of adult ewes and the result gives an indication on flock management with regard to labour.

Information about the division of work days in a flock of 300 ewes is given in Table V and Figure 10. The table is reprinted from Becker's *Sheep Breeding*[2], published in 1948 by the Sheep-breeders' Association. Becker is himself a shepherd of 30 years' standing. According to Table V, 4.43 work days are spent per

TABLE V

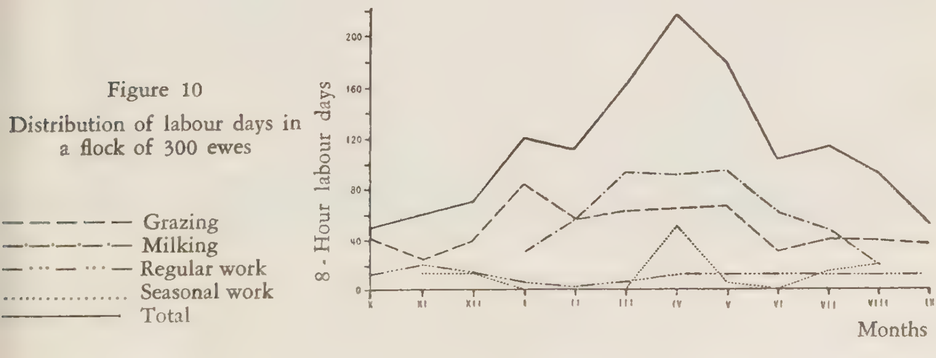
Distribution of work days in a flock of 300 ewes in addition to young stock and rams

Month	Grazing A* Days	Grazing B** Days	Grazing Average Days	Milking Days	Regular work at the sheepshed Days	Special seasonal work Days	TOTAL Days
October	31	47	39	—	12	—	51
November	—	—	26	—	20	15	61
December	—	—	40	—	15	15	70
January	—	—	84	31	6	—	121
February	—	—	56	56	3	—	115
March	—	—	62	93	6	—	161
April	—	—	65	90	12	50	217
May	—	—	67	93	12	6	178
June	—	—	30	60	12	—	102
July	31	47	39	47	12	15	113
August	31	47	39	20	12	20	91
September	30	45	37	—	12	—	49
Total			584	490	134	121	1,329
%			43.94	36.87	10.08	9.11	100.00
Per ewe							4.43

*A: flocks with normal grazing conditions: 1 grazing day = 1 work day
**B: flocks with difficult grazing conditions: 1 grazing day = 1.5 work day
(Reprinted with permission from D. Becker, *Sheep Breeding*.)

Figure 10

Distribution of labour days in a flock of 300 ewes



adult ewe per year, including the work on young stock and rams. The presently accepted figure is 4.75 work days, as some additional activities have been introduced in the intervening years. Grazing (44%) and milking (37%) are the major items, with the remainder being spent on regular work (supplementary feeding, shed cleaning, dipping, milk recording) and on seasonal work (shearing, controlled service, etc.). In larger flocks a system of two shifts has been introduced, which greatly facilitates the work of the shepherd without increasing the total amount of work days.

V. DESCRIPTION OF THE BREED

18. *Body conformation*

The body measurements were taken with a Lydtin-rule and a tape at the registration of the individual ewes for the Flock Book. Since 1954, due to the great number of ewes to be registered, body measurements were taken only from those selected for breeding ram lambs. Measurements of the top 2,039 ewes were taken for the calculation of the figures in Table VI. The only criterion for registration is the milk yield of a ewe, but neither pedigree nor body development. The means can, therefore, be considered to be representative of the breed.

19. *Body measurements*

Table VI gives the mean, S.E. and S.D. of the body measurements of 2,039 adult ewes and 421 adult rams. Most of the ewes have a straight back-line, concave or convex backs being rare; body length almost equals height at

TABLE VI
Body measurements of 2,039 ewes and 421 rams

Body measurements	Ewes				Rams			
(in cm)	M	S.E.	S.D.	range	M	S.E.	S.D.	range
Height at withers	69.26	0.0681	3.077	58 — 78	77.70	0.1531	3.142	66— 87
Height at back	69.25	0.0671	3.028	59 — 79	77.04	0.1507	3.092	68— 86
Height at crupper	69.37	0.0677	3.059	58 — 79	77.27	0.1496	3.069	67— 86
Length of body	68.46	0.0792	3.580	56 — 80	74.80	0.2050	4.207	62— 87
Depth of chest	32.72	0.0365	1.649	28 — 39	35.85	0.1085	2.227	28— 42
Breadth of chest	19.53	0.0497	2.243	13 — 28	20.67	0.1063	2.181	16— 28
Breadth of pelvis	21.43	0.0436	1.970	15 — 28	23.81	0.0986	2.023	18— 30
Chest circumference	94.04	0.1379	6.229	76 —116	100.70	0.3571	7.327	80—124
Shin-bone circumference	7.96	0.0031	0.139	6.5— 9.5	9.35	0.0266	0.545	8— 11

withers; the chest is well developed, especially in depth; animals with rather narrow but relatively deep chests are often found; the average shin-bone circumference of 7.96 cm (11.5% of height at withers), indicates that the ewes have a strong skeleton. Measurements of all rams used for service were taken,

Figure 11
Ram CHAM No. 0792/1020. Breeder: Ein Harod. Owner: Ginegar. Age: 5 years. Height: 85 cm. Weight: 110 kg. Dam: No. 722/791, Ein Harod; milk yield: 533 kg; daily maximum yield: 3.2 kg, 5th lactation. Sire: NASICH No. 0443/259, Ein Harod; out of No. 485/104, milk yield 564 kg, daily maximum yield 3.5 kg, 5th lactation

Figure 12
Ewe No. 841/9233—B. Breeder and owner: Ginegar. Age: 3 years. Height: 74 cm. Weight: 75 kg. Milk yield: 730 kg. Daily maximum yield: 2.5 kg, 1st lactation. Dam: No. 587/7083; milk yield: 491 kg; butter fat 6.5%, 32.006 kg per annum; daily maximum yield: 2.5 kg, 2nd lactation. Sire: CHAM No. 0792/1020, Ginegar; out of No. 722/791 milk yield 533 kg, daily maximum yield 3.2 kg, 5th lactation

Figure 13

Ewe No. 596—B/7513. Breeder and owner: Ein Harod. Age: 7 years. Height: 76 cm. Weight: 65 kg. Milk yield: 888 kg; butter fat 6.2%, 55.011 kg. Daily maximum yield: 5.5 kg, 6th lactation. Dam: No. 440—B/3739; milk yield: 414 kg; daily maximum yield: 2.6 kg, 3rd lactation. Sire: NASICH No. 0443/259. Ein Harod; out of No. 485/104 milk yield 564 kg, daily maximum yield 3.5 kg, 5th lactation

Figure 14

Yearling No. 193. Breeder and owner: Ein Harod. Born: 18.XII. 1954. First lambing: 15.IV.1956 (precocious lambing at the age of 16 months). Age: 2 years. Height: 75 cm. Weight: 52 kg. Milk yield: 350 kg. Daily maximum yield: 2.9 kg (late season lambing). Dam: No. 596—B/7513, Ein Harod (vide Figure 13 for further particulars). Sire: AHARON No. 0445/554, Merhavia: out of No. 573/547, milk yield 413 kg, daily maximum yield 2.0 kg, 5th lactation

and those of the top 421 were employed in this study; they too can be accepted as being representative of the breed.

The body measurements were taken primarily for practical purposes in order to retain the excellent body conformation of the breed and to guard against any deterioration which might result from over-emphasis on milk production.

The first body measurements were taken with the foundation of the Flock Book in 1942. The means were then calculated from the first 310 ewes, and a point system was worked out from the results, allowing a maximum of 25 points for body conformation (vide Table VII).

TABLE VII

Body conformation point system

	Ewes	Rams
Body height	4	6
Body length	4	5
Chest development	4	6
Shin-bone	3	3
Size of udder	3	—
Form of udder	2	—
General impression	5	5
Total	25	25

In 1947, when 2,039 ewes had been measured, the means were recalculated in order to check and, if necessary, to correct the figures required for the allocation of points for each body measurement. However, the differences found were so small that the original point system was confirmed; it has been retained up to the present.

The same procedure was followed for rams. The means, calculated originally from 130 animals, were checked when the number reached 421. No corrections were required in the application of the point system. The allocation of points is shown in Table VII.

In selection work, the accepted rules, as regards body conformation, are as follows:

(a) female lambs may be bred at the discretion of the breeder by taking into consideration the body conformations of both dam and sire;

(b) for the rearing of ram lambs for breeding purposes, a minimum of 16 points is required from both the dam and the sire. In cases of exceptionally good dams with fewer points but with high milk production, the ram lamb is allowed to be reared under the supervision of the breeding committee which decides on its disposal at the weaning time, when distribution of surplus rams to other flocks is made. It can be seen that the point system is not rigidly employed, with a certain amount of discretion allowed in dealing with the few exceptionally good animals. The rules are, however, strictly followed in all other cases.

20. *Outward appearance*

There is a strong tendency in the better flocks to breed for uniform colour markings. The desired type is that most frequent in the Awassi and it has the following description:

The head is uniformly brown, of a lighter or darker shade, but chocolate brown is most frequent. White markings on the front or along the profile line are not objected to, as long as brown predominates. Unwanted are entirely black, white or spotted heads. The ears are large and drooping. Small fleshy ears, which sometimes occur, are being slowly eliminated; diminutive ears or the rare absence of outer ears are not tolerated. The head is strongly built, but relatively long in relation to its breadth so that it is fine rather than coarse. The rams usually possess heavy horns, polled rams being unusual. The ewes are mostly polled, though a small percentage has horns.

The wool is white. Animals with black, brown or spotted wool are rare.

The fat tail is large and it indicates the nutritional condition of the animal. Its outside part is covered with wool, while the inner part is bare. Though the fat tail causes some inconvenience at milking and at mating, when it has often to be lifted by the shepherd to facilitate service, its existence is believed to regulate the nutritional condition of the animal, enabling it to draw on its fat reserves during the time of heavy milk production. Docking was tried several times, following which heavy fat cushions accumulated at the base of the tail and in the posterior part of the animal. This practice is now rejected by most sheep-breeders.

With regard to the outward uniformity of the animals, it is, of course, realized that is has no connection whatsoever with productive capacity. Here, too, an attitude similar to that on body conformation is taken. The selection of female lambs is left to the discretion of the breeder. There are some flocks with a remarkable uniformity in the general appearance of the sheep. These flocks comprise many of the best milk producing flocks, which can afford to cull valuable animals only because of their defective colour.

The accepted rule in the rearing of ram lambs is to reject and sell for slaughter all those with colour defects belonging to the less productive groups. Only ram lambs with colour defects, but coming from exceptionally good dams, are retained and sold later to beginner flocks, which in due time will try to achieve outward uniformity as well as greater productivity. Only ram lambs with diminutive ears are invariably culled.

21. *Live weight*

The live weight of the lamb is generally taken during the first 24 hours of its life and is duly entered on the dam's card. The weight is again recorded at weaning time or when the lamb is sold. Adult animals were weighed at the time of their registration in the Flock Book. The results are given in Table VIII, according to age and sex of sheep.

The birth weight of 83.9% of the recorded single ram lambs was 4.0—5.5 kg. The corresponding range in 88.2% of the recorded single ewe lambs was 3.5—5.0 kg, whilst that of 82.9% of the recorded twin lambs

TABLE VIII
Live weights

		n	M kg	S.E. kg	S.D. kg	range kg
At birth						
single born	males	2,010	4.57	0.0165	0.738	1.5— 7.0
	females	1,854	4.29	0.0152	0.657	2.0— 7.0
twin born	males	225	3.83	0.0490	0.734	2.0— 6.0
	females	227	3.59	0.0461	0.695	2.0— 5.5
At weaning (55—65 days old)						
	males	439	25.70	0.1437	3.011	18 — 36
	females	703	20.52	0.0818	2.170	15 — 29
Adults						
	rams	391	74.36	0.5241	10.363	44 —110
	ewes	1,211	50.32	0.2081	7.240	24 — 74

(rams) and that of 83.9% of the recorded twin lambs (ewes) was 3.0—4.5 kg.

In 87% of the ram lambs at weaning (55—65 days old) the weight was 22.0—30.0 kg. The lambs were, however, from exceptionally good dams, chosen for breeding of ram lambs. In 84.3% of the ewe lambs, the weight was 18.0—23.0 kg.

Of the adult rams, 71.3% weighed 64.0—84.0 kg; in 79.6% of the adult ewes, the range was 42.0—58.0 kg.

VI. REPRODUCTION

22. *Material used*

The registration cards of all ewes from four flocks from different parts of the country were used in this investigation (vide Table IX). The cards from each flock were calculated separately and observed differences are pointed out in the respective tables, giving at the same time the number of cards actually used. Within the flocks, the cards of the ewes registered in 1942—43 were calculated separately and compared with the cards of the ewes presently in the flock, i.e. up to 1953—54 for Ein Harod and Geva, and up to 1952—53 for Sarid and Hulda. At the inception of the Flock Book in 1942—43, there were altogether 362 registered ewes, of which 43.81% belonged to Ein Harod (104), Geva (41) and Sarid (13).

TABLE IX

Flock	Cards	Region
Ein Harod	950	Jezreel Valley
Geva	389	Jezreel Valley
Sarid	221	Affula
Hulda	229	South
Total	1.789	

23. *Mating*

Mating is strictly controlled in the above mentioned four flocks as well as in the majority of all other registered flocks. Rams are housed in separate pens and yards throughout the year, but are generally taken to pasture together with the ewes. About one month before the start of the mating season, the rams are penned during the day and special food is given in order to get them in good condition for service.

Mating usually begins in the second half of June, as at Ein Harod and Geva, though in some flocks it may not start until the beginning of July, as in Sarid and Hulda. A shepherd may postpone the beginning of mating due to local environmental conditions.

Teaser rams, provided with aprons, are used to find the ewes on heat in the morning before the flock goes out to pasture and in the evening when it returns to the fold. Lists assigning every ewe to a particular ram are prepared beforehand. The ewes on heat are isolated, and if many ewes come on heat on the same day, they are kept at home to allow adequate intervals of rest between service. Good rams give only one service per ewe, so that they may serve a maximum number of ewes. When a ram is not overworked on some particular day, then two services may be given to the same ewe. Rams are first used for service at the age of one and a half years.

Controlled service is employed for about $2\frac{1}{2}$—3 months, following which rams are allowed to join the flock on pasture where any ewes missed before will be served. Regional meetings are held in some settlements before the start of the mating season and the younger shepherds are then shown by instructors the technique of controlled service.

Artificial insemination is still in the experimental stage. Experiments during six consecutive years have been carried out, but the low rate of conception has so far prevented its use on a larger scale. As the importance of artificial insemination is fully appreciated in Israel, the experiments are being continued.

24. *Lambing*

The distribution of lambing is given in Table X and Figure 15. The figures, based on the flocks of Ein Harod, Geva, Sarid and Hulda, may be taken as the average for the Improved Awassi.

The figures were arrived at by using the cards for the first 158 ewes in addition to those of 916 ewes belonging to the above mentioned four flocks. Yearlings are treated separately; in addition to the 165 found in these four flocks, data for 146 yearlings from 13 additional flocks were used, thus bringing the total of yearlings to 311.

Yearlings usually lamb at about 15 months of age. Out of the 311 animals observed, 71.70% lambed between 1.III and 1.V, 15.12% before 1.III and

13.18% later than 1.V. The first observed lambing took place on 8.I and the latest on 7.VI. The record is held by a yearling which lambed at the age of 13 months.

TABLE X
Distribution of lambing

onth	Date	311 yearlings		1,074 adult ewes	
		No.	%	No.	%
‹	1—15			2	0.05
	16—31			4	0.09
‹I	1—15			8	0.18
	16—30			139	3.17
‹II	1—15			1,047	23.89
	16—31			1,327	30.28
	1—15	3	0.97	714	16.29
	16—31	5	1.61	431	9.84
I	1—15	14	4.50	341	7.78
	16—28	25	8.04	144	3.29
II	1—15	40	12.86	79	1.80
	16—31	48	15.43	66	1.51
V	1—15	70	22.51	28	0.64
	16—30	65	20.90	33	0.75
/	1—15	28	9.00	9	0.20
	16—31	11	3.54	6	0.14
/I	1—15	2	0.64	2	0.05
	16—30			2	0.05
Total		311	100.00	4,328	100.00

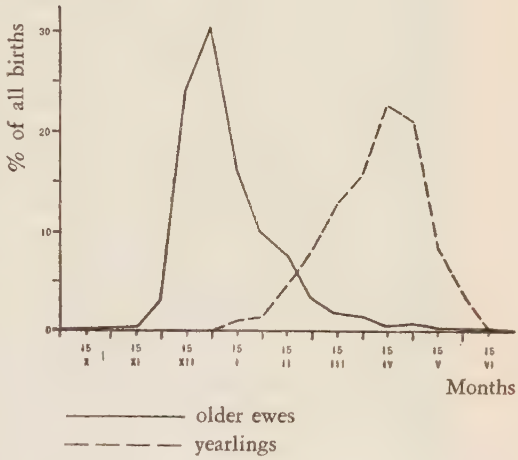


Figure 15
Distribution of lambing

All 2—13 year old ewes are considered adult. Out of the 4,382 lambings, 88.09% occurred in the period 1.XII—15.II which can be taken as the main lambing season of the breed. About 3% lambed in the second half of November, mainly at Ein Harod and Geva, with only sporadic cases before that date. Mating was, therefore, fairly well controlled with regard to the start of the mating season. 8.42% of the lambings took place later than 15.II. This last figure represents the undesirable late lambings and ought to be restricted as far as possible. The earliest recorded lambing occurred on 13.X and the latest on 21.VI.

25. *Concentration of lambing*

In ewes kept mainly for milk production, the concentration of lambing is of prime importance. At the end of the milking season, the whole flock is dried off, without considering the late lambers still in full milk production.

This is mainly done for reasons of flock management and labour. The late lambers cannot, therefore, reach their full annual yield, as no individual treatment is practicable in a large flock. Moreover, late born lambs do not develop properly, due to the high temperatures of the middle and late summer. Late lambings are, therefore, not only an inconvenience, but often cause actual losses in the flock. Attempts to improve the situation are being made continuously by eliminating, as far as possible, ewes tending towards late lambings.

It is interesting to compare the Improved Awassi with other breeds. Mason and Dassat [13] found that in the Italian Langhe 93.6% of the recorded lambings occurred during the three-month period January-March. Against this, 91.37% of all recorded lambings took place in the three-month period December-February in the Awassi.

Table XI shows the concentration of lambings in each of the four flocks. Geva shows the smallest percentage of late lambings (6.16%), while Ein Harod has the highest figure (9.86%). It has to be recalled, however, that the majority of the ewes on which this Table is based, comes from Ein Harod. This percentage remains almost constant if we exclude the first 104 registered ewes; it is 9.51% for 1,371 lambings from 420 ewes now in the flock.

TABLE XI
Concentration of lambing

Flock	Lambing period						Lambings
	Early 13.IX.—30.XI.		Predominant 1.XII.—15.II.		Late 16.II.—21.VI.		
	No.	%	No.	%	No.	%	
Ein Harod	88	4.11	1,840	86.03	211	9.86	2,139
Geva	57	5.96	841	87.88	59	6.16	957
Sarid	2	0.34	534	90.97	51	8.69	587
Hulda	6	0.86	645	92.27	48	6.87	699
Average	153	3.49	3,860	88.09	369	8.42	4,382
1942—43 lambing season	19	6.93	223	81.39	32	11.68	274

Details of 274 lambings during the 1942—43 season are also incorporated in Table XI, in order to enable us to point to any improvements since the establishment of the Flock Book.

The concentration of lambing during the most efficient period, 1.XII—15.II, shows a slight improvement of 6.70%. This was achieved by stricter enforcement of controlled service which brought about a reduction in lambings before this period. The slight reduction in late lambings is probably due to better general environmental conditions, as no special measures were taken to reduce the number of late lambings in the flock.

26. *Behaviour of individual ewes*

Before taking steps to improve the concentration of lambing by selecting and culling persistent late lambers, the behaviour of individual ewes must first be investigated from this point of view. This may give an indication as to the regularity or irregularity in the onset of the oestrus in individual ewes. It is pointed out that the four flocks were always provided with a sufficient number of effective rams and the senior shepherds were experienced in controlled service. It seems probable, therefore, that the late lambings are mainly caused by various factors influencing the sexual behaviour of the ewe. Without entering into the nature of these factors, it has been attempted to find their combined final effect as represented by the lambing dates during the life of the ewe, and by the span covering the lambings of consecutive years. A superficial study of lambing dates provided evidence for the existence of some such regularity. For example, ewe No. 2442 from Sarid had seven lambings, four of which took place on the same date (14.XII), one on 20.XII, one on 21.XII and one (her second) on 17.I. A span of 34 days thus covers all her lambings.

Of the 1,789 cards from the four flocks, 100 cards were taken at random for each group of ewes with 5, 6, 7 and 8 lambings. 75 ewes with 9 lambings and 25 with 10 lambings were combined in one group. Only ewes which lambed for the first time at the age of two years were included in this survey.

The lambing dates of each ewe were recorded and this enables us to calculate the number of days between the earliest and the latest lambing.

27. *Results*

A scrutiny of this material shows that the ewes can be divided into three different types with regard to the concentration of lambing (vide Table XII).

TABLE XII

Types of lambing in individual ewes

Lambings	Ewes	Types of lambing: Concentrated (a)	Almost concentrated (b)	Irregular and widespread (c)
5	100	70	21	9
6	100	60	28	12
7	100	62	32	6
8	100	47	41	12
9&10	100	60	26	14
Total	500	299	148	53
%	100.00	59.80	29.60	10.60

TABLE XIII

Examples of lambing periods in ewes

Ewe's Register No.	Lambings	XI 1—15	XI 16—30	XII 1—15	XII 16—31	I 1—15	I 16—28	II 1—15	II 16—31	III 1—15	III 16—30	IV 1—15	IV 16—30	Length of lambing period Days	No-lambing interval Days
(a) All lambings concentrated															
23	8			5, 5, 6, 8, 9, 10**, 11	19*									14	
63	8			3, 4**, 6, 7 8*, 11, 12, 13, 13										10	
47	9			8, 9**, 11, 13, 13,	16, 17, 19, 22*									14	
841	9		30*, 30	1, 2, 2, 5, 8**, 11	17									18	
2250	10		19, 23, 24, 24	2*, 7, 7, 7, 15	24**									35	
(b) Almost all lambings concentrated															
4	8		23*	5, 12	16, 17, 19, 22								27**	29	1:136
891	8		30*	2, 3, 4, 6, 12, 15				11**						16	1: 57
344	9		27	3, 5, 9, 9, 13**, 15	17*							3		21	1:106
2031	9			4**, 4, 9, 10, 11	22*, 22	1						15		28	1:103
182	10			4, 7**, 10, 10, 12, 15	16, 26*			13, 26						22	2:48+13
(c) Irregular and widespread lambings															
276	8				23, 26	14**	17		25, 25	15*		10		108	
1491	8			4	16	1, 8**	18			1, 13	26*			112	
911	9			6	21*			2, 12	17		22**, 24		16, 20	135	
2429	9				24	1, 15		10**, 13	23	15	22		25*	122	
872	10	15	30	11	18, 26		18**, 25	10, 13		3*				108	

* First lambing   ** Last lambing

(a) Ewes lambing within a concentrated period of the year, and which showed no long intervals of "not lambing" to disturb the general impression obtained. This group accounted for 59.80% of the observed cases.

(b) Ewes with almost all their lambings falling within a concentrated period of the year. This group comprised 29.60% of the observed cases. Although the concentration of lambing in this group is similar to (a), 138 (93.24% of the 148 ewes in this group) had one lambing clearly out of line. The other 10 ewes (6.78%) had two lambings after a long interval of not lambing. The length of this interval is 28—136 days, with an average of 56.12 days. This average points to the regular onset of the oestrus, which recurs every 17—19 days, and indicates that three such periods elapsed before a ewe conceived. It was found, however, that in 42 ewes (28.38%) the not lambing interval was due to the first lambings, indicating that two-year old ewes tend to lamb somewhat later than older ones. Furthermore, 27 cases (18.24%) were last lambings; this shows that the advanced age of ewes has some influence. These 27 cases were divided as follows:

4 in the group of	6	lambings
7 " " " "	7	"
6 " " " "	8	"
10 " " " "	9—10	"

In the remaining 79 cases (53.38%), the lambing which fell out of line was not caused by age. While the reason could not be traced with certainty, it is most probable that these late lambings were due to weak bodily condition of the ewes in that year.

(c) Ewes with irregular lambings spread over an extended period. This group made up 10.60% of all the observations. The lambing period was 65—138 days, with an average of 98.49 days for the 53 animals. Some of the extreme cases in the group were also due to the first or the last lambing of a ewe increasing the length of the lambing period, but keeping in line with the irregular and widespread lambings of the particular ewe. Only two out of these 53 ewes had no late lambings at all. The total lambings in this group amounted to 386, out of which 115 (29.79%) occurred later than 15.II. It appears, therefore, that this group is primarily responsible for the occurrence of late lambings in the flock.

Five examples from each of the three groups are given in Table XIII. Persistent late lambers seldom occur.

Out of the 500 cases investigated, only 13 ewes never lambed prior to 1.I and only 2 never lambed before 1.II.

It is pointed out, however, that the investigated ewes were all good milkers and had reached, in one lactation, at least 275 kg of milk, this being the minimum required for registration in the Flock Book in those years. It is possible, therefore, that some persistent late lambers did not achieve this yield and were not registered, or that they were culled in time for being poor milkers.

TABLE XIV

Regularity of lambing in the majority of Awassi ewes

Interval during which almost all lambings took place	Ewes in each group	
Days	No.	%
6—17	29	6.49
18—32	119	26.62
33—47	150	33.56
48—62	96	21.48
63—77	44	9.84
78—92	8	1.79
93—95	1	0.22
Total	447	100.00

Mean = 41.59 days ± 0.7966
S.D. = ± 16.842 days

Table XIV gives data on the interval between first and last lambing in respect of 447 ewes with a minimum of 5 lambings and falling into groups (a) and (b) described above. However, sporadic cases of late lambing in individual ewes of group (b) are excluded from this Table. The average period for all the 447 ewes with 5—10 lambings was 41.59 days. In 81.66% the period was 18—62 days, in 6.49% it was as short as 6—17 days, whilst in the remaining 11.85% it extended to 63—95 days.

The average lambing period increased with the number of lambings but slightly, resulting in a difference of about 13 days between ewes with 5 lambings and those with 9—10 lambings. Only once did the lambing period extend to 95 days — in a ewe with 10 lambings.

28. *Sex ratio*

Table XV contains particulars on sex ratio, twinning, barrenness, abortions and mortality of lambs at birth or up to seven days thereafter, separately for each of the four flocks, together with average figures for each flock.

This table was compiled on the basis of information collected as follows: Ein Harod — the first 104 registered ewes in 1942—43, and 420 ewes in the flock in 1953; Geva — 41 original ewes and 190 ewes now in the flock; for these two flocks it was possible to compare the years 1942—43 and 1953—54, with regard to twinning, barrenness, abortions and lamb mortality; Sarid — 150 ewes, which figure is a combination of 13 ewes in the flock in 1942—43 and 137 ewes at present; Hulda — this flock had no registered ewes in 1942—43, and all the 169 ewes are now in the flock. Altogether 1,074 ewes, which had 4,549 births, formed the basis for the calculation of the figures in Table XV.

Of the total of 4,973 lambs, 2,505 (50.37%) were males and 2,468 (49.63%) were females. Johanson[9] gives for the Swedish breeds, in an investigation of 13,241 lambs, 49.30% ± 0.435 for males. Further information on the sex ratio is given below in the section on twinning.

TABLE XV

Sex ratio
Twinning, barrenness, abortion and lamb mortality

Flock	Year	Ewes	Births				Lambs						Barrenness		Abortions		Mortality of lambs up to 7 days old	
			Singles	Twins*		Total	Sex ratio				Total	Pro 100 births						
							♂		♀									
			No.	No.	% of Total	No.	No.	%	No.	%	No.	No.	No.	%	No.	%	No.	%
Ein Harod	1942	104	709	45	5.84	754	418	52.32	381	47.68	799	105.97	9	1.17	5	0.65	11	1.38
	1953	420	1,330	142	9.65	1,472	790	48.92	825	51.08	1,615	109.71	17	1.14	7	0.47	45	2.79
Total		**524**	**2,039**	**187**	**8.58**	**2,226**	**1,208**	**50.04**	**1,206**	**49.96**	**2,414**	**108.49**	**26**	**1.15**	**12**	**0.53**	**56**	**2.32**
Geva	1942	41	218	15	6.44	233	129	52.02	119	47.98	248	106.44	6	2.57			2	0.81
	1953	190	663	71	9.67	734	407	50.56	398	49.44	805	109.67	14	1.91			22	2.73
Total		**231**	**881**	**86**	**8.89**	**967**	**536**	**50.90**	**517**	**49.10**	**1,053**	**108.89**	**20**	**2.07**			**24**	**2.28**
Sarid	1953	150	537	88	14.08	625	353	49.44	361	50.56	714	114.24	5	0.80	5	0.80	12	1.68
Hulda	1953	169	670	61	8.34	731	408	51.52	384	48.48	792	108.34			2	0.27	10	1.26
Total		1,074	4,127	422	9.28	4,549	2,505	50.37	2,468	49.63	4.973	109.32	51	1.12	19	0.42	102	2.05

* Two triplets included: 1 in Ein Harod ♂♀♀; 1 in Sarid ♂♂♂.

29. *Barrenness*

Barrenness amounted to 1.12% of the total expected births. There were small differences between the first three flocks, with no case of barrenness recorded from Hulda.

30. *Abortions*

Abortions amounted to 0.42% of the total births. Only small differences were found between the different flocks, whilst Geva had no abortions in its 231 registered ewes.

31. *Mortality of lambs*

Still-born lambs and those which died within 7 days after birth amounted to 2.05% of the total 4,973 lambs born. Ein Harod and Geva, with a larger number of ewes examined, showed a slightly higher mortality than Sarid and Hulda.

32. *Twinning*

Out of a total of 4,549 births, 422 (9.28%) were twin births. Considering only ewes now in the four investigated flocks, the corresponding figures are 3,562 births and 362 (10.16%) twin births.

In an investigation made by the author in 1945, registered ewes chosen at random from 22 flocks were examined with the following result: total births — 4,090; twin births — 226 (5.52%). Two triplets were then found, one in Hazorea (♂♀♀) and one in Merhavia (♂♂♀).

The ratio of twinning nearly doubled since 1945, from 5.52% to 10.16%. In Ein Harod and Geva, which in 1942 showed somewhat higher ratios than in 1945, the increase has been 3.81% and 3.23%, respectively, thus raising the ratios to the present 9.65% and 9.67%. The highest ratio was reported from the registered ewes at Sarid — 14.08%, whilst Hulda showed only 8.34%. Two triplets have also been recorded from the present flocks, one at Ein Harod (♂♀♀) and one at Sarid (♂♂♂).

Although an increase in twinning would surely result in an increase of the overall income of a flock, no special steps to encourage twinning have been taken in any flock. The recorded increase seems to be due to changed environmental influences.

The distribution of twinning was compared with that of single births in order to find the eventual influence of environmental conditions on the ewes when they are on heat. The remaining 715 cards of the four flocks were also

examined for this purpose and the dates of all twin births noted. The distribution of 836 twin and 3,960 single births is given in Tables XVI and XVII.

TABLE XVI

Distribution of lambing — twins

Month	Date	Lambings No.	Lambings %
X	1—15	1	0.12
	16—31	—	—
XI	1—15	3	0.36
	16—30	57	6.82
XII	1—15	294	35.17
	16—31	217	25.96
I	1—15	88	10.52
	16—31	53	6.34
II	1—15	49	5.85
	16—28	24	2 87
III	1—15	15	1.79
	16—31	14	1.67
IV	1—15	10	1.20
	16—30	8	0.96
V	1—15	2	0.24
	16—31	1	0.12
Total		836	100.00
Up to 15.XII			42.47

TABLE XVII

Distribution of lambing — singles

Month	Date	Lambings No.	Lambings %
X	1—15	2	0.05
	16—31	4	0.10
XI	1—15	8	0.20
	16—30	126	3.18
XII	1—15	922	23.28
	16—31	1,205	30.43
I	1—15	665	16.79
	16—31	396	10.00
II	1—15	310	7.38
	16—28	129	3.26
III	1—15	310	7.83
	16—31	55	1.39
IV	1—15	25	0.63
	16—30	25	0.63
V	1—15	7	0.18
	16—31	5	0.13
VI	1—15	2	0.05
	16—30	2	0.05
Total		3,960	100.00
Up to 15.XII			26.81

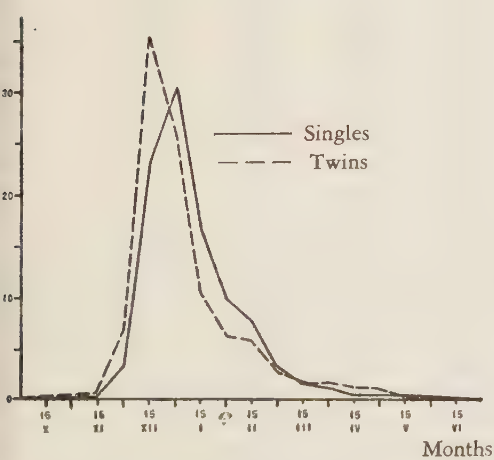


Figure 16
Distribution of lambing with singles and twins

It was found that 42.47% of all twins were born before 15.XII, with only 26.81% of all single births occurring by this date. The difference of 15.66% clearly indicates that there is some environmental influence on the ewes in the early heat period (vide Figure 16).

This confirms the observation made by Marshal and Potts, as reported by Reeve and Robertson [16], "that the twin lambs in a flock are produced chiefly in the early part of the lambing season.

This was attributed to one of two causes: (1) the ewes in the best condition would tend to come to heat and therefore to lamb first, or (2) the food and pasturage are more nutritious early in the season and cause production of more ova by the ewes bred at that time."

Under the climatic conditions of Israel there is practically no green grazing on natural pasture after the end of April, that is for nearly two months before the start of the mating season. The most important foodstuffs in this period are the grains found by the sheep grazing in the stubble fields after the harvests of barley and wheat. The effect was equivalent to flushing and further investigation was therefore conducted in this direction.

The investigation was extended to include another 20 flocks from different parts of the country. A comparison of the flocks and of the different regions should help to clarify the problem.

5,078 registered ewes from 24 flocks were examined, and 1,473 ewes which had born twins, once or several times, were recorded. The average of ewes with twin births was found to be 29.10%. The twin births per twinning ewe averaged 1.42. The distribution of twinning was calculated for each flock separately, and the twins born prior to 31.XII averaged 63.19%.

The flocks were grouped geographically; 15 of the better flocks are surveyed in Table XVIII. The last column of the table shows the breeding

TABLE XVIII

Twinning in sheep in different regions of Israel

Flock / Region	Ewes	Ewes with twins		Twin births per twinning ewe	Twinning up to 31.XII	Flock's breeding standard 1953—54 average milk yield
	No.	No.	%		%	kg
Ein Harod	950	275	28.95	1.46	77.62	380.55
Geva	389	129	33.16	1.49	67.71	418.77
Tel Yosef	310	95	30.64	1.46	62.58	301.94
Moledet	158	44	27.85	1.32	82.75**	273.57
Jezreel Valley (average)	1.807	543	30.05	1.46	72.95	—
Sarid	221	102	46.15	1.52	52.26	329.55
Ginegar	300	113	37.67	1.64**	44.33*	323.00
Dovrat	132	54	40.91	1.57	82.34	269.43
Affula (average)	653	269	41.19	1.58	54.82	—
Ramat Hashofet	201	35	17.41	1.11*	74.36	335.06
Ein Hashofet	307	50	16.29*	1.28	50.01	329.11
Ephraim Mountains (average)	508	85	16.73	1.21	59.22	—
Kfar Giladi	282	92	32.62	1.31	71.91	308.52
Kfar Szold	146	32	21.92	1.44	63.05	317.18
Hulata	135	28	20.74	1.29	58.34	278.82
Galilee (average)	563	152	27.00	1.33	67.49	—
Kfar Menahem	90	42	46.67**	1.29	66.67	302.61
Givat Brenner	122	40	32.72	1.52	63.94	293.50
Hulda	229	67	29.62	1.30	56.32	291.28
South (average)	441	149	33.79	1.36	61.39	—
24 flocks average	5.078	1,473	29.01	1.42	63.19	

* Minimum ** Maximum

standard of the flock based on the average milk yield of the 1953—54 season. This affords a comparison of the flocks as to their quality.

Generally, with but few exceptions, the figures for flocks from the same region conform, especially with regard to the percentage of twinning ewes and to the number of twin births per such ewe. The influence of regional differences on twinning is thus indicated. The average figures for the different regions are given graphically in Figure 17.

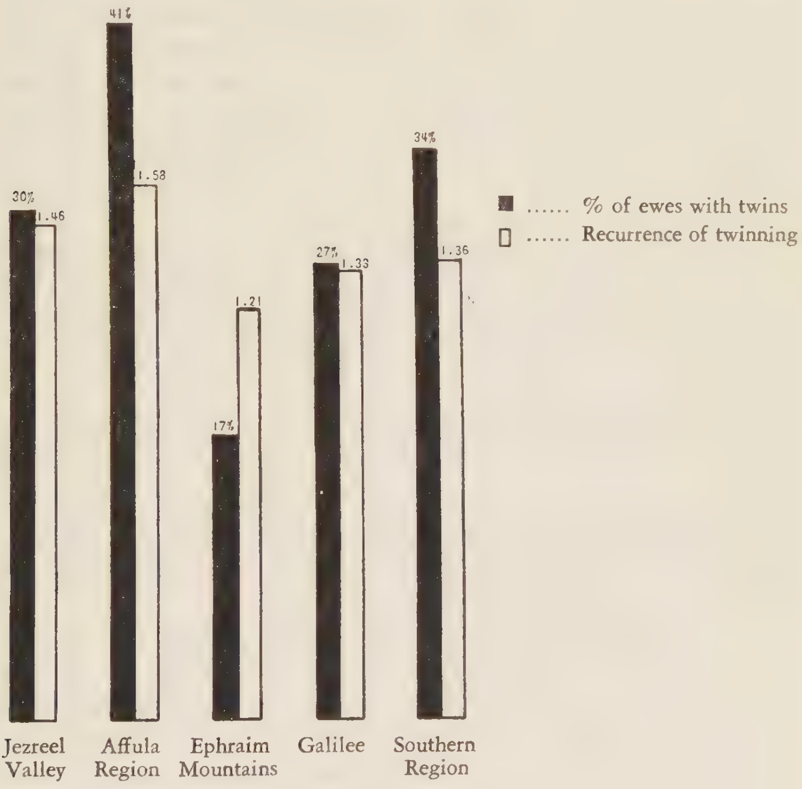


Figure 17
Regional differences in twinning

The group of flocks from the Affula region shows the highest figures in the above two details. Sarid, already mentioned for its high percentage of twinning, derives this from the large number of ewes which bore twins (46.75%), rather than from ewes in which twinning recurred. Ginegar, situated close by, has the highest recurrence of twinning (1.64) yet recorded in the country, whilst the ratio of twinning ewes, though high enough, is lower than that of Sarid by 8.78%. The third flock in this region, Dovrat, has high figures in both items. The percentage of twin births occurring before 31.XII is in this

region markedly smaller than the country-wide average. Twinning in Sarid is extended by 15 days, so that 74.40% of all twin births take place up to 15.I. No particular concentration of twinning could be observed in Ginegar in the early stages of the lambing season. Dovrat is the exception in this respect — 82.34% of all twin births occurred before 31.XII, which is almost the highest figure in the country.

The flocks in the Ephraim Mountains are at the other extreme, having the smallest percentage of twinning ewes, 17.41% and 16.29%, respectively, as well as the lowest recurrence of twinning by the same ewes. Both these flocks are among the best in the country, as can be seen from their breeding standard. The small percentage of twinning cannot, therefore, be attributed to faults in the general management of these flocks, but they are most probably the result of local environmental conditions. The two flocks also differ in the concentration of twinning, Ramat Hashofet having 74.36% and Ein Hashofet only 50.01% of twin births prior to 31.XII.

The flocks in the Jezreel Valley show close conformity in the figures of all three principal items, with the exception of Moledet, which has somewhat smaller percentages of twinning ewes and recurrence of twinning, whilst the concentration of twinning in this flock is as high as 82.75% — the highest in the country.

With the exception of Kfar Giladi, the percentage of twinning ewes in the Galilee is below the country-wide average. The Kfar Giladi flock, situated on the northern border of Israel, lives under conditions quite different from those of Hulata and Kfar Szold; this explains its higher ratio of twinning ewes and the higher concentration of twinning, while the recurrence of twinning falls below the average of the country.

Of the flocks in the southern region, that of Kfar Menahem has 46.67% twinning ewes (the highest figure in the country), and fairly dense twinning, whilst the recurrence of twinning is rather low. The other two flocks, Givat Brenner and Hulda, differ in all the three points investigated. The two latter possess less twinning ewes than Kfar Menahem, although they are a little above the country-wide average. The differences between the three flocks indicate a certain dissimilarity in local conditions in the southern region, as the three flocks are situated quite apart one from the other.

Although the differences with regard to twinning and its concentration, as caused by environmental conditions in the surveyed regions are quite evident, the real causes could not be clearly traced. They are probably the result of several factors, such as climatic conditions, differences in the quality of available pastures, the intensity of the very hot khamsins and the resulting effects on the vegetation of the region. Moreover, the figures were obtained during several years, in respect of each flock, giving an overall picture for each of the regions. The flocks with the highest ratios of twinning ewes, as well as a

higher recurrence of twinning, are found in regions with extensive grain growing, such as the Affula region, the Jezreel valley, and the neighbourhood of the Kfar Menahem flock. This is an additional indication that grazing on the stubble fields affects the incidence of twinning.

The results so far obtained from the investigation of the influences of environmental conditions on twinning and lambing were discussed with some of the most experienced shepherds in the country, in order to hear suggestions from the men doing the actual work, for further examination of this point. One of the senior shepherds from Ein Harod, Mordechai Livne, proposed to compare the lambings of the 1948—49 season with the averages for all years. He had observed that the Ein Harod flock had during 1948—49 more twinnings than in any other year. If this proved to be correct, then the cause could clearly be traced to extensive grazing on grain fields, as 1948—49 was quite exceptional in this respect.

TABLE XIX

Influence of environmental conditions on lambing and twinning (the Ein Harod flock)

Month	Date	Single births				Twin births			
		All years average		1948—49		All years average		1948—49	
		No.	%	No.	%	No.	%	No.	%
X	1—15					1	0.25		
	16—31	2	0.10			—	—		
XI	1—15	3	0.15			2	0.50		
	16—30	73	3.74	28	8.04	36	8.96	10	13.33
XII	1—15	518	26.54	158	45.40	174	43.28	43	57.34
	16—31	595	30.48	76	21.84	99	24.63	13	17.34
I	1—15	266	13.63	41	11.78	24	5.97	3	4.00
	16—31	160	8.20	13	3.74	15	3.73	1	1.33
II	1—15	148	7.58	13	3.74	13	3.23	3	4 00
	16—28	66	3.38	4	1.15	12	2.99	1	1.33
III	1—15	42	2.15	2	0.57	7	1.74	—	—
	16—31	31	1.59	4	1.15	6	1.49	—	—
IV	1—15	17	0.87	5	1.44	6	1.49	1	1.33
	16—30	19	0.98	2	0.57	6	1.49		
V	1—15	5	0.26	—	—	—	—		
	16—31	3	0.15	—	—	1	0.25		
VI	1—15	2	0.10	1	0.29				
	16—30	2	0.10						
Total lambings		1,952	100.00	348	100.00	402	100.00	75	100.00
Up to 15.XII			30.53		53.44		52.99		70.67
Up to 31.XII			61.01		75.28		77.62		88.01

Increase of twinning:
Average (Table XV) from 2,226 births: 8.58%
1948—49 from 423 births: 17.73%

During spring and summer of 1948, some of the fields under cereals were not harvested due to the War of Independence. Also, many crops were stunted and unsuitable to modern automatic harvesting, though the ears were full of grain. The shepherds permitted their flocks to browse in such fields, but they took the precaution to gradually accustom the animals to the rich fodder.

Results of this investigation are collected in Table XIX and Figures 18 and 19.

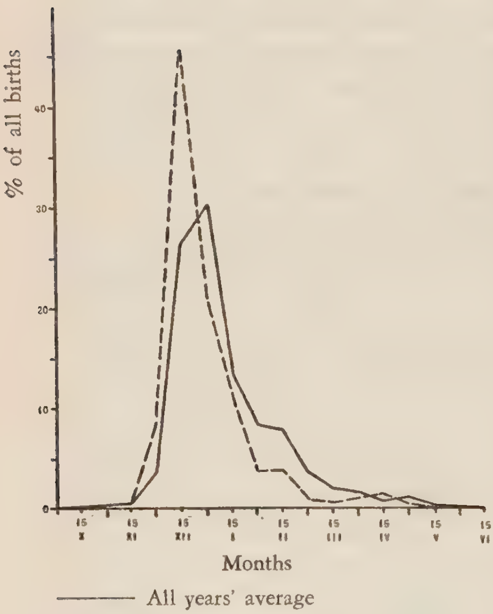


Figure 18
Influence of environmental conditions on lambing (Ein Harod flock)

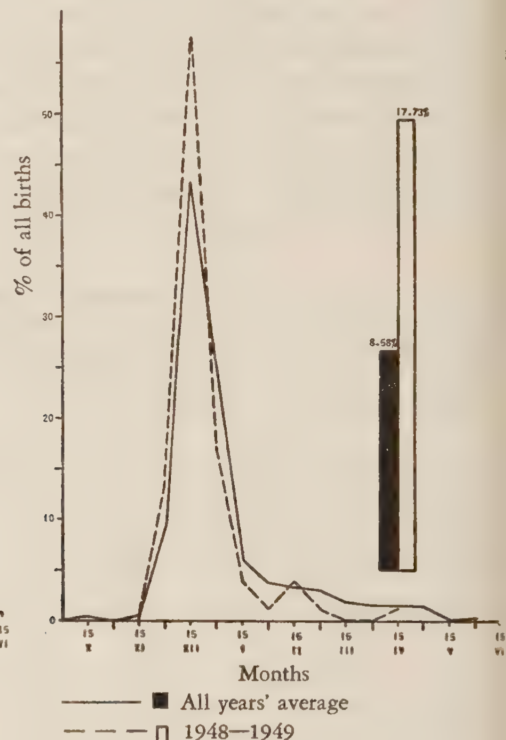


Figure 19
Influence of environmental conditions on twinning (Ein Harod flock)

The Ein Harod flock was taken as a basis, because it possessed sufficient records to afford the two figures to be compared. The flocks of Geva, Sarid and Hulda were also examined as a check on the results obtained at Ein Harod.

The figures clearly indicate that in 1948—49 there was a greater concentration of lambing, both in single and in twin births. 53.44% of all single births took place prior to 15.XII, this being almost 23% above average. Up to the end of December, 75.28% of the single births occurred, compared to the average of 61.01%.

This tendency was even more pronounced in the twin births in the Ein Harod flock. Up to 15.XII, 71% of the twin births occurred, compared to

the average of 53%. Twinnings were more than 17% higher than single births in 1948—49. By the end of December, 88% of all twins had been delivered, more than 10% over the average of all years.

The increase in twinning, as given at the bottom of Table XIX, was exceptionally high in the 1948—49 lambing season. It amounted to 17.73% from 423 births, whereas the average for Ein Harod, as per Table XV, was 8.58% from 2,226 births. Twinning in the 1948—49 season was more than double the all-year average of the flock. This increase from 8.58% to 17.73% (an absolute increase of 106.64%) is the probable limit of the influence of grain feeding, before the onset of the mating season, under the conditions prevailing in the Jezreel valley. From the economic point of view, it would of course never be feasible to supply the sheep during this period with a practically unlimited amount of grain, with the sole purpose of achieving a similar increase of twinning.

Geva, which is not far from Ein Harod, showed exactly the same trend in 1948—49, thus confirming the results obtained from the Ein Harod flock. However, only 147 cases of lambing are available from Geva for the 1948—49 season, and the corresponding figures are, therefore, smaller. Up to 15.XII.1948 about 7% more single births occurred than the average all-year figure for this flock. Up to the same date, 64.72% of the twinnings had taken place, which is 18.58% more than the single births during the same period. Out of the 147 lambings, 17 twin births were recorded, which gives 11.56% for the 1948—49 season, compared with the all-year average of 8.89% for this flock (vide Table XV). The increase in twinning was therefore not very great.

In the other two examined flocks, Sarid and Hulda, no comparable figures could be obtained, as the total number of lambings available for the year 1948—49 was small. In Hulda, however, one instance apparently connected with the special conditions of 1948—49 should be pointed out. Hulda is close to the former battlefield and the flock consequently did not receive the usual treatment and care. Only two out of a total of 104 births recorded in that year were twin births. The all-year average for twinning in this flock is, however, 8.34% (vide Table XV).

The recurrence of twinning in individual ewes has been partially dealt with in the discussion of Table XVIII. Twinning in the Awassi is low in comparison with the prolific Ostfriesian milch sheep or the Langhe breed. The average of twin births per twinning ewe is 1.42. Additional information on this problem is contained in Table XX, with all twinning ewes arranged according to the number of lambings.

Of the 1,473 ewes which bore twins, once or several times, during the time they were under observation, 1,428 appear in the Table; the remaining 45 ewes lambed only once. These figures give some indication on the influence on twinning of external and genetic factors.

TABLE XX

Recurrence of twinning

Number of lambings	1 No.	1 %	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No.	5 %	6 No.	6 %	Total
2	81	92.05	7	7.95									88
3	160	84.21	28	14.74	2	1.05							190
4	167	80.29	35	16.83	5	2.40	1	0.48					208
5	192	72.18	61	22.93	10	3.76	3	1.13					266
6	153	65.77	53	22.75	19	8.15	7	3.00	1	0.43			233
7	123	57.21	49	22.79	30	13.95	12	5.58	1	0.47			215
8	64	49.23	39	30.00	17	13.08	8	6.15	2	1.54			130
9	33	51.56	21	32.81	3	4.69	6	9.38			1	1.56	64
10—11	21	61.77	6	17.65	3	8.82	4	11.76					34
Total	994	69.61	299	20.94	89	6.23	41	2.87	4	0.28	1	0.07	1,428

(Column headings: Number of twinnings 1–6; Number of ewes, No. and %.)

TABLE XXI

Influence of age on twinning

(a) Incidence of twin births in the flocks of Ein Harod, Geva, Sarid and Hulda

Age Years	Ewes in each group	2 No.	2 %	3 No.	3 %	4 No.	4 %	5 No	5 %	6 No.	6 %	7 No.	7 %	8 No.	8 %	9 No.	9 %
2	140	7															
3	242	6	23.08	20	76.92												
4	323	12	12.50	38	39.58	46	47.92										
5	221	7	8.05	15	17.24	29	33.33	36	41.38								
6	211	7	5.78	19	15.70	21	17.36	31	25.62	31	35.54						
7	180	4	3.51	12	10.53	18	15.79	21	18.42	38	33.33	21	18.42				
8	153	5	3.47	6	4.17	20	13.89	21	14.58	35	24.31	26	18.05	31	21.53		
9	101			3	3.16	10	10.53	6	6.31	21	22.10	22	23.16	14	14.74	19	20.00
Total	1,571																
Total births		1,571		1,431		1,189		866		645		434		254		101	
Total twin births		48	3.05	113	7.90	144	12.11	115	13.28	137	21.24	69	15.90	45	17.72	19	18.81

(Column headings: Twin births at the age of years 2–9; Twin births, No. and %.)

The influence of environmental conditions, some of which were described above, is expressed by the 69.61% of ewes which twinned only once. By restricting ourselves to the 714 ewes with 5, 6 and 7 lambings, we find that 65.13% twinned only once; it is clear, therefore, that the percentage of sporadic twinning is very high.

Recurrence of twinning was recorded in 434 ewes (30.39%) of all the observed cases. Though part of this may be caused by environmental conditions, some genetic predisposition is indicated, e.g. those persistent twin lambers which bore more twins than singles.

Ewes which have only twins are rare; in fact, only one ewe out of 208 observed had nothing but twins, and she lambed only four times. Ewes with three or more twinnings totalled 135 (9.45%) out of all the ewes; the most prolific of all recorded ewes had six pairs of twins in 9 lambings.

Although in Israel the emphasis in selection work is put on the milk yield of individual animals, the genetic predisposition to twinning should also be taken into consideration, in order to increase the twinning ratio in the Awassi. The prospects for achieving this aim are slight, but it is worth trying, inasmuch as no harm is likely to be caused to the main target, the increase of milk production of the breed. With the ample breeding material available, preference should be given in each class to such rams and ewes in the pedigrees of which recurrence of twinning has been recorded.

It is well known that one of the non-genetic factors influencing twinning in sheep is the age of the dam. In order to ascertain the influence of age on the fertility of the Awassi ewes, as expressed by the frequency of twin births, two investigations were undertaken and the results compared.

In the first investigation the ratio of twin births in each age group was obtained and compared to the total births in that age group.

The ewes from the four flocks already mentioned before, were divided into age groups up to the age of 9 years. Ewes of the higher age groups were ignored, as they were too few to give reliable results. The total number of ewes was 1,571, with a total of 6,491 lambings. The results are given in Table XXI.

Precocious lambings at the age of 15 months were omitted. Twin births seldom occurred in yearlings; only two cases were recorded in 311 observed precocious lambings.

If we compare the ewes of each age group separately, we find a steady increase of twin births with the age of the ewe. The highest ratio of twin births is in ewes of six years of age. The ratio decreases as from the seventh year. However, this decrease is not very pronounced, due to the smaller number of ewes in the higher age groups. This is probably the reason for the discrepancies appearing in the group of the 9-year old ewes.

The bottom line of Table XXI expresses the twin births as the percentage of all births in the respective age groups; it will be noted that only 3.05%

of the recorded 1,571 births in the 2-year age group were twin births. The percentage shows a steady increase, up to the 6-year group, in which 21.24% of the recorded 645 births produced twins.

The ratio in the 7-year age group declines to 15.90%, whilst there is a slight increase afterwards, probably due to the inaccuracy caused by the smaller number of recorded births in the higher age groups.

TABLE XXII

Influence of age on twinning

(b) Percentage of twinning ewes

Age group Years	Twinning ewes No.	%
2	45	3.27
3	88	6.40
4	190	13.82
5	208	15.13
6	266	19.35
7	233	16.94
8	215	15.64
9	130	9.45
Total	1,375	100.00

In the second investigation, the influence of age on twinning is based on all the twinning ewes up to nine years of age, as recorded in 24 flocks (vide Table XXII). There were 1,375 such ewes and the ratio of each age group follows closely that given in the preceding table. The conformity is maintained up to the age of seven years. In the 8- and 9-year groups the number of twinning ewes continues to decline (vide Table XXII), whilst the number of twin births (vide Table XXI) actually increased in these age groups.

The results of both investigations are consolidated in Figure 20, which shows the peak of both curves at the age of six years.

These results are in accordance with the results obtained by Johansson and Hansson in an extensive investigation on five different breeds in Sweden, as reported by Reeve and Robertson [15]. The conclusion was that "there is generally a steady rise in average number of lambs per birth in all breeds till 5—6 years of age, with a gradual regression afterwards".

Kelley's investigations [10] of a merino flock in Australia gave the following results: "The most common twinning ages were from 7 to 10 years, although the average for all ages from 3 to 12 years (7.1%) was exceeded also by ewes 5—6 years of age".

The sex combinations among twins are shown in Table XXIII, for the 2,086 twins recorded. Of 4,172 lambs, there were 50.50% males and 49.50% females. This sex ratio conforms closely with the one given in Table XVI for lambing in general, as worked out from 4,973 lambs, and where the males accounted for 50.37%.

There was, however, a striking difference in the sex ratio amongst the 422 twins recorded in Table XV and the 2,086 twins recorded in Table XXIII, showing clearly that 422 twins were too small a figure to give reliable results. The males made up 47.04% in the former and 50.37% in the latter.

By employing a larger number of twins, a close conformity of figures for the sex ratio of single lambs and for that of twin lambs was obtained. Altogether, 8,299 lambs were recorded, 4,127 born as singles and 4,172 as twins.

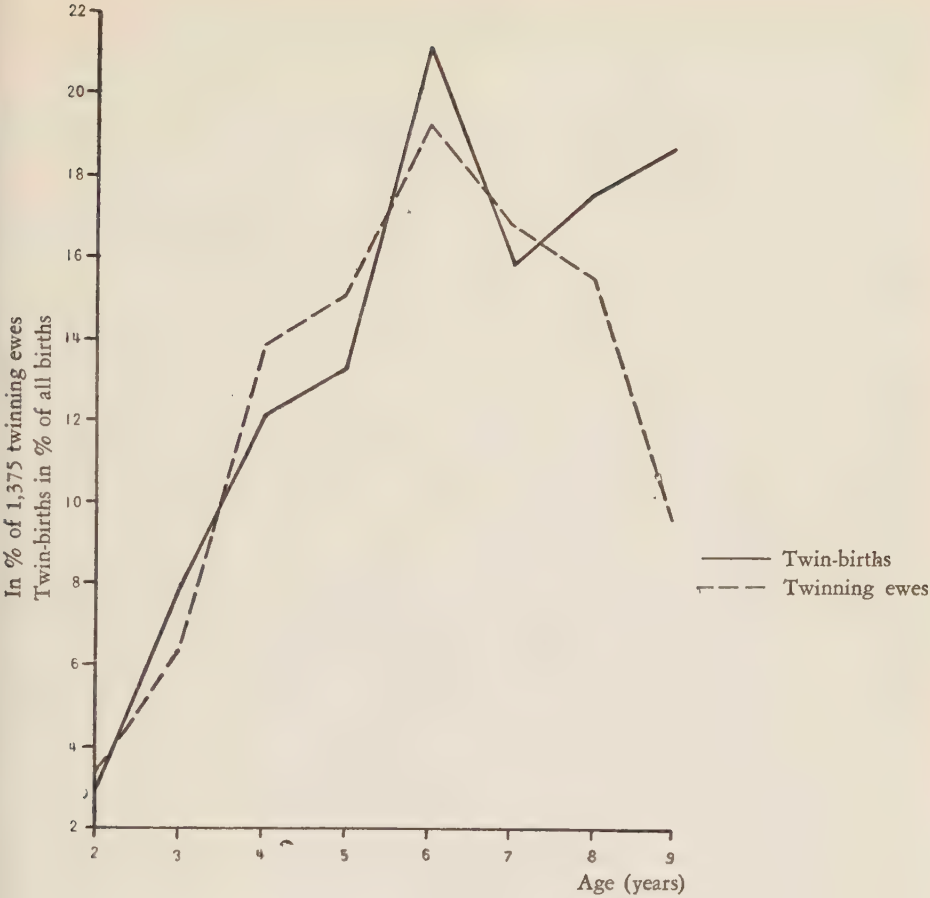


Figure 20
Influence of age on twinning

The sex ratio obtained from the 8,299 recorded cases is 4,214 male lambs (50.78%), while 4,085 were female lambs (49.22%). The slight preponderance of male lambs as given in Table XV is thus confirmed.

TABLE XXIII

Sex combinations and sex ratio in twins

Twin pairs: Sex combinations							Lambs: Sex ratio				
♂♂		♀♀		♂♀		Total	♂		♀		Total
No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.
527	25.26	506	24.26	1,053	50.48	2,086	2,107	50.50	2,065	49.50	4 172

The sex combination in twins shows that of the 2,086 twin births 527 (25.26%) were males, 506 (24.26%) females and 1,053 (50.48%) were of different sex.

Johansson[9] in his investigation of the Swedish breeds found the following sex combination figures for 5,088 twin births: 22.77% males, 24.35% females and 52.77% different sex twins.

The figures for the female twins are almost equal in both investigations. In the male twins, the figure found for the Awassi is just over 2% higher than that of the Swedish breeds, resulting in a correspondingly smaller percentage for the pairs with differing sexes.

Since 1945, an increase in twinning among the registered ewes has been recorded, rising from 5.52% to 10.16%. As no special measures to account for this rise were taken, the increase is most probably the result of the general improvement of environmental conditions in which the sheep are now kept.

Regional differences between the flocks were found in respect of twinning, indicating that flocks situated in grain growing regions usually have a higher ratio of twinning.

Grazing on the stubble fields, after the collection of the grain harvest, seems to be one of the environmental factors favourably influencing the ratio of twinning in the flocks. Such grazing possibilities should therefore be fully exploited by the flocks. Experiments should be made to test this by flushing ewes with a small daily supplementary ration a month before the start of the mating season and during its most predominant period. This would at the same time probably influence favourably the concentration of lambing in the flock too. The economic side of these experiments should be carefully investigated.

Together with these measures, the genetic predispositions for twinnings should also be taken into consideration by selecting rams and ewes with a record of twinning in their pedigrees.

33. *Precocity*

The Awassi ewes usually lamb for the first time at the age of two years. By improving the conditions of feeding, housing and general management of the advanced flocks, the Improved Awassi show an increasing tendency towards precocious lambing. This may be seen from Table XXIV, in which the precocious lambers, recorded from four flocks, are given as a percentage of the total number of the examined ewes.

Of the 158 ewes registered in 1942, only two ewes, both from Ein Harod, lambed as yearlings (1.26% of the number observed).

Of the 916 registered ewes in the four flocks in 1953, 165 (18.02%) lambed as yearlings.

It should be noted that precocious lambing has tended to increase. For instance, in the Sarid flock 19 out of the 38 recorded cases were born in 1949—50

TABLE XXIV
Precocious lambing

Flock	Year	Ewes	Ewes lambing precociously	
			No.	%
Ein Harod	1942	104	2	1.92
	1953	420	85	20.24
Geva	1942	41	—	—
	1953	190	10	5.26
Sarid	1942	13	—	—
	1953	137	38	27.74
Hulda	1953	169	32	18.93
Total	1942	158	2	1.26
	1953	916	165	18.02

and 1950—51. An unusual case in this respect was recorded in the Dorot flock. This flock was established in 1951—52 by buying 250 two-months old female lambs after weaning, from the following flocks: 150 from Ein Harod, 25 from Geva, 25 from Hulda and 50 from Sde Nahum. In addition, 47 adult ewes were acquired from the Ashdot Yaakov flock. In 1952—53, out of 250 yearlings 169 (67.6%) lambed, and produced an average milk yield of 163 kg per yearling, thus realizing a considerable income in the first year of its existence. Following this example, several other flocks were established, consisting only of female lambs purchased after weaning. Hitherto the establishment of flocks in this way was not practiced by the settlements, as they were unwilling to wait for about two years until the flock commenced to provide some income.

Based on the above observations, it may be assumed with certainty that the Improved Awassi will show in the not too distant future that it is more precocious than anticipated.

It seems important, therefore, to examine the precocious lambings with regard to the age of the yearlings at lambing and also with regard to the date of their own birth, in order to find the influence of late lambings in this direction.

For this purpose, the dates of birth and ages at first lambing of all ewes which lambed as yearlings were ascertained in 17 flocks.

Table XXV gives the frequencies of the yearlings' age at lambing, with intervals of 29 days. The number of days over one year of age is given; the range was from one year and 20 days to one year and 180 days, or approximately from 13 to 18 months of age.

The mean was 1 year + 101.24 days ± 1.5616 or about 15½ months. The majority of yearlings (83.55% of the observed cases) fell between 14 and 17 months age at the day of lambing.

Table XXVI gives the distribution of the dates of birth for the same 389 yearlings.

TABLE XXV
Yearlings' age on lambing day

Days over one year of age	Yearlings in each group	
	No.	%
20— 32	6	1.54
33— 62	39	10.02
63— 92	110	28.28
93—122	131	33.68
123—152	84	21.59
153—182	19	4.89
Total	389	100.00

Mean = 1 year and 101.24 days ± 1.5616
S.D. = ±30.800 days

TABLE XXVI
Distribution of dates of birth in 389 yearlings

Month	Date	Yearlings	
		No.	%
X	1—15		
	16—31	6	1.54
XI	1—15	4	1.03
	16—30	32	8.22
XII	1—15	113	29.05
	16—31	153	39.33
I	1—15	59	15.17
	16—31	17	4.37
II	1—15	4	1.03
	16—28	1	0.26
Total		389	100.00

308 yearlings (79.17%) were born prior to the end of December, 76 (19.54%) in January, while only 5 (1.29%) were born in February.

Late lambings, after 16.II, previously described as undesirable in the flock, do not seem to reach sexual maturity in time to enable them to lamb as yearlings. Out of the 389 cases observed, only one such case was found, which was born on 24.II.1944 and delivered a lamb on 25.IV.1945, when about 14 months old. This is an additional reason for restricting, as far as possible, the occurrence of late lambings in the flock.

The average age of the registered ewes in the flocks in 1953 was calculated from the records used for the compilation of Tables X and XV.

The average age of the 420 registered ewes of Ein Harod was 5.37 years, of the 190 ewes of Geva 5.88 years, of the 137 ewes of Sarid 5.63 years, whilst for the 169 ewes of Hulda it was 6.15 years.

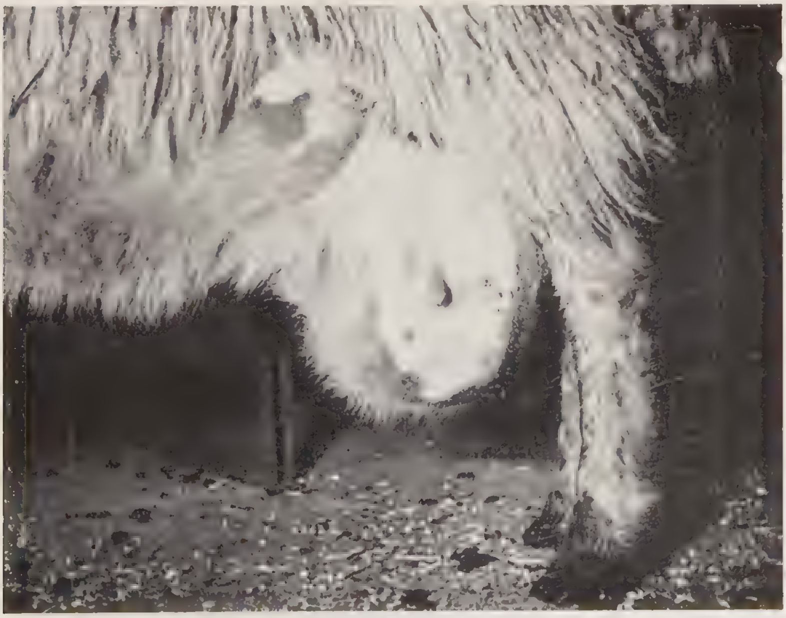
The average of the first ewes registered in 1942—43, of which none are now with the flocks due to death and culling, was also calculated in respect of Ein Harod and Geva. The 104 ewes from Ein Harod had an average life time in the flock of 9.36 years, and for the 41 ewes from Geva it was 7.83 years.

VII. MILK PRODUCTION

34. *Milk recording*

The recording of milk production is carried out by the shepherds themselves, as they are fully aware of its importance for the improvement of their flocks. All the milking ewes in the flocks are kept under strict control, as it is of

Figures 21—22
Udder development in Improved Awassi ewes



Figures 23—24
Udder development in Improved Awassi ewes

prime importance, for the economic success of the flock, to find the poor producers and to remove them from the flock. This is even more important, in the first years of the flock's existence, than to find the good producers, because the flocks are in any case supplied with high quality rams and, if necessary, with female lambs reared in special flocks for this purpose. All recording is done by weighing the milk and not by measuring its volume, the latter method being inaccurate. The ewes are milked twice daily at intervals of 12 hours.

In beginner flocks it is usual to record twice monthly in order to get accurate figures of individual yields. This requires additional labour which is not always available. Therefore, recording is obligatory once every month, and it must be performed on a fixed day.

35. *Butter fat recording*

Because butter fat recording has to be done by specially trained persons, it is expensive, and is restricted to flocks breeding rams. There are 14 such flocks in the country. The recorder takes samples for fat recording only from ewes selected for breeding rams. He also calculates the yield of butter fat at the end of the milking season and submits the results to the manager of the Flock Book. After checking, a copy is forwarded to the shepherd concerned.

36. *Standardization of records*

In order to arrive at the total milk yield produced by a ewe during a lactation period, the milk suckled by the lamb must be added to the quantity actually milked. Not all lambs suckle for an equal number of days. Male lambs earmarked for sale may be separated from their dams when they are only 14 days old, while male and female lambs, kept for rearing, are allowed to suckle for at least 60 days. In cases when the lamb dies shortly after birth, almost the entire quantity of milk is recorded as milked. The figures calculated from the records must therefore be standardized in order to show the milk producing potential of each ewe. Without this measure, no effective selection can be initiated in the flock.

Shepherds in Israel were loath to apply the system of starving the lambs for 24 hours on days of milk recording, because of the detrimental effect this starvation might have on the lamb's development.

Elsewhere [4] the author devised a system of standardization of milk records based on a fixed suckling period of 30 days. But this system could not be applied to the Awassi, as long as its course of lactation was not defined by statistics based on a sufficient number of reliable records. In addition, the calculations had to be made by shepherds, so that it became necessary to evolve a procedure simple enough to be adhered to by them without putting too much strain on their time, and which could be done after the milking season.

The quantity of milk suckled by the lamb in the Awassi was found by multiplying the first recorded daily milk yield of the ewe by the number of suckling days allowed to the lamb. For this purpose, the exact date of lambing and the date of weaning, sale or death of the lamb has to be recorded. The result gives an approximation of the quantity of milk suckled. It is obvious that the lamb obtains more milk during its 12—13 hours stay with the dam than the milked amount. In most cases, when the lamb suckles for about 60 days, the suckled milk is underestimated because the lactation curve has already started its decline. The limit is therefore arbitrarily set at 75 days of suckling; when this limit is exceeded, the figure is underlined in red, indicating that the annual yield for the year cannot be considered to be correct. Such cases are excluded from later progeny tests based on a comparison of dam/daughter yields.

This system was in use in all milk recording flocks in the country from 1937—38 to the 1953—54 milking season. Despite its deficiences, it has given very satisfactory results. In order to reduce the errors caused by the estimation of the milk suckled by the lamb, three factors are taken into consideration besides the annual yield in estimating the milk producing capacity of the ewes: the maximum daily yield, the length of lactation and the average weight increase of the lamb per day of suckling. These factors formed the basis for the point system for the evaluation of ewes.

This method was examined in 1951—52 and 1952—53 at the Government Stock Farm, Acre, and the results are given in Table XXVII. The recorded quantity taken by the lamb was compared with the "estimated" quantity as shown in the card of the ewe. In 1951—52, 30 ewes, one of which had to be excluded during the experiment, were used and in 1952—53 another 16 ewes.

TABLE XXVII

Quantity of milk suckled by the lamb until weaning (60 days)

Ewes	Quantity of suckled milk						Excess of recorded over estimated yield	
	Recorded			Estimated				
	M.	S.E.	S.D.	M.	S.E.	S.D.		
	kg	kg	kg	kg	kg	kg	kg	%
45	124.78	2.4405	16.371	84.89	3.9101	26.229	39.89	31.97

Recording was carried out once a week, on a fixed day and at fixed hours. On the preceding day, the lambs were separated from their dams and the udders were milked dry in order to ascertain the 24 hour milk production of each ewe. On the following day the lambs were weighed before and after suckling, the difference being the exact quantity of milk suckled by the lamb. After suckling, the udder was milked dry and any remaining milk was recorded.

Provisions were made to collect droppings during suckling. In both years the experiments were undertaken by N. Doron, the shepherd in charge at Acre.

At the end of the suckling period of 60 days, the total quantity of milk taken by the lamb was obtained by multiplying the average daily yield by 60. Thereafter, the dams were recorded together with the other ewes on the following recording day of the flock. The daily yield then obtained was multiplied by 60 and the "estimated" quantity of suckled milk was thus found in the same way as is usually followed in the flocks.

The difference between "recorded" and "estimated" quantity of the suckled milk is given in the right-hand column of the table, in kg and also in percent of the "recorded" total milk taken by the lamb.

The results of this experiment confirm that the lamb suckles more milk than estimated and calculated by the recording system in use in Isarel. The total annual milk yield of the ewe is, therefore, actually higher than the figure given in the reports published by the Flock Book.

The main purpose of the experiment was to examine the methods used and to express the differences in percent. We can, therefore, combine the results obtained during the two years, without taking into consideration the eventual changes in environmental conditions.

The "recorded" quantity of milk suckled by the lamb during the 60-day period averaged for the 45 lambs 124.78 kg, with a minimum of 92.220 kg and a maximum of 164.200 kg.

The "estimated" milk quantity, as calculated for the same ewes, according to the method used in the country, averaged for the 45 ewes 84.89 kg, the minimum being 45.0 kg, and the maximum 153.720 kg.

The difference of 39.89 kg indicates that in these 45 cases the quantity of the milk suckled by the lambs was underestimated by 31.97%.

All lambs were allowed to suckle all the milk from their dams; the now accepted method of partial suckling was not employed.

The introduction of partial suckling, where lambs are allowed only part of the dam's milk, the rest of their food requirements being provided by other foodstuffs, has made it possible to introduce further improvements in milk recording.

In the 1954—55 season, it was decided to keep the lambs separated from their dams for 24 hours on milk recording days. This is, however, not done until the lamb is at least 14 days old, so that it will not suffer unduly when deprived of its mother's milk for 24 hours. By eliminating the "estimation" of that portion of the milk which is suckled by the lamb, the annual milk yield of each ewe represents now more accurately the ewe's total milk production from the day of lambing until the last day of milking. Thus, milk recording in Israel has been brought into line with the requirements of the Study Commission on Sheep-breeding of the European Association for Animal Production.

37. *The course of lactation*

The material used for this analysis consisted of 263 lactations of ewes of the Ein Harod flock. Only lactations were used, in which the lambs were disposed of not later than 15 days after birth. Excluded were lactations begun after 31.I and those of less than 300 kg of milk. This was done in order to eliminate ewes in which the lack of stimulus on the udder caused by prolonged suckling, may have involved irregularities in the course of lactation. Such effects are probably smaller in heavy milkers. This material seemed suitable for a calculation of the ratio of the total milk yield of the ewe in consecutive periods of 30 days, from which the lactation curve could be drawn.

The results obtained at Ein Harod were checked with 192 lactations from Geva and with 38 from Sarid. A comparison of the percentages for the consecutive intervals of the lactation period in the three flocks shows close conformity, indicating that the figures obtained at Ein Harod were correct. The results could, therefore, be arrived at by taking the data for all 493 lactations; they are given in Table XXVIII and Figure 25. In the first month 19.95% of the total yield are produced, with a slight decline in each of the following two months, but still amounting to 57.39% during the first 90 days. Thereafter, the decline in each of the following months is somewhat steeper as the yield diminishes by 2.43%, 3.45%, 3.64% and 2.40%, respectively, amounting in the 7th, the last, month of lactation to 6.17% of the total yield.

There were, however, some ewes producing in their second month of lactation more milk than in the first. 159 such lactations were observed, amounting to 32.25% of the total.

It is interesting to compare this lactation course with that given by Wallace [19] for two non-milking breeds of sheep, the Suffolk and the Border-Leicester Cheviot cross. In the Suffolks the length of lactation was about 5 months. In the first month, 37.9% of the total yield was delivered, followed by steep

TABLE XXVIII
Course of lactation

Intervals during lactation period	Lactations	Milk yield per interval			
		M.	S.E.	S.D.	
Days		kg	kg	kg	%
1— 30	493	70.73	0.5748	12.763	19.95
31— 60	493	68.62	0.4890	10.857	19.35
61— 90	493	64.17	0.4328	9.610	18.09
91—120	493	55.55	0.4133	9.178	15.66
121—150	493	43.31	0.4267	9.475	12.21
151—180	465	30.39	0.4110	8.862	8.57
181—210	254	21.87	0.4380	6.981	6.17
Total		354.64			100.00

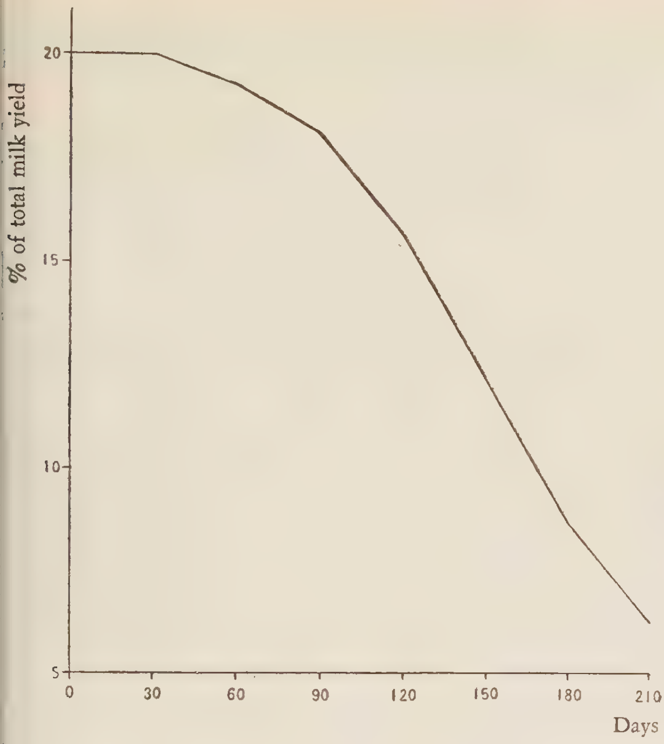


Figure 25
Mean lactation curve, showing milk yields at consecutive 30-day intervals

declines of 7.4%, 10.1% and 9.2% for each of the following months. In the Border-Leicester×Cheviot ewes the length of lactation was even shorter, about 4 months. In the first month, 38.3% of the total yield was delivered, and the decline in each of the following months amounted to 8.9%, 8.3% and 9.9%, respectively.

38. *Classification of ewes*

The results of the year's milk recording and all other data pertaining to a ewe are entered on its Sheep Shed Card at the end of the season. A translated specimen of this card is shown in Figure 26, showing the kind of information collected by the breeder. When the cards are brought up to date, the ewes are classified on special forms supplied by the Flock Book management. The forms enable the breeder to group his ewes, according to their milk yield, into two separate frequency distributions, with class differences of 10 kg of milk. These are:

(a) *The annual milk yield*

All ewes which have been milked during the preceding season are entered. The numbers of adult ewes are entered in ink, the first lactations which started

SHEEP BREEDERS ASSOCIATION

7513 Flock Book No.
14.VI.54 on 65 kg Weight
23 Points for body conformation
85;86 Total points

Ein Harod (Ichud) Farm

Dam 440B		Sire NASICH	
Dam	Sire	Dam	Sire
✓	✓	485	Chagay

596B Ewe's ear mark No.
440B Family Awassi Breed
24.XII.49 Born on 15 Breeding generation
brown spots Special signs brown Colou[r]

LAMBING

Sold to farm	Ear mark No.	weight	Date of weaning	Date of sale	Date of slaughter	Date of death	Birth weight ♂	Birth weight ♀	Date of abortion	Date of lambing	Service ram	Service date
		8.5			2.IV.51			3.5		9.III.51	?	?
		28	25.II.52	suckles son of 326B				dead		24.XII.51	Esav	26.VII.51
		20	5.VI.53				4			24.III.53	?	?
Ein Harod		23	23.II.54					4.5		23.XII.53	?	?
	193	23	23.II.55				4			18.XII.54	Aharon	18.VII.54
	375	26	20.II.56				4.5			14.XII.55	Ger	13.VII.5

WOOL		MILK PRODUCTION									
kg	Date of shearing	Total lactation yield	Estimated milk production during suckling period: total milk	daily yield	Suckling days: partial	Suckling days: full	Butter fat %	Milk yield	Milking period: milking days	last day	first day
		296	55	2.3	–	24		241	128	16.VIII.51	3.IV.51
		607	214	3.4	–	63		393	160	5.VIII.52	26.II.52
		181	104	1.4	–	74		77	56	31.VII.53	6.VI.53
		466	149	2.4	–	62		317	163	5.VIII.54	24.II.54
		719	–	4.3	–	65	6.0	719	253	30.VIII.55	18.XII.54
		890	–	5.5	66		6.2	890	262	5.IX.56	14.XII.55

Cause of exit .... Left flock o[n]

Figure 26a
Sheep Shed Card (front)

MILK RECORDING

195......	195......	195......	195......	1955-6	1954-5	1953-4	1952-3	1951-2	1950-1	Year / Date	
					5%					1	December
					4.3					15	
				5.5	5%					1	January
				6%	4.3					15	
				5.0	5.2%					1	February
				5.7%	3.8			3.4		15	
				5.0	3.5	2.4				1	March
				5.8%	6 %			3.7		15	
				3.3	3.4	2.4			2.3	1	April
				5.2%	6.4%			2.9		15	
				3.2	2.9	2.0			2.3	1	May
				6.0%	6.8%			2.0		15	
				2.2	1.8	1.5	1.4		1.9	1	June
				7.0%	7.2%			1.7		15	
				1.6	1.6	1.4	1.4		1.3	1	July
				7.6%	7.8%			1.9		15	
				0.7	0.8				11	1	August
				8.6%	8.2%					15	
										1	September
										15	
										1	October
										15	
										1	November
										15	

REMARKS

Figure 26b
Sheep Shed Card (reverse)

at the usual age of 2 years are entered in pencil, and the first lactations of yearlings, which started when the ewe was only 15 months old, are entered in red pencil. Thus, a picture is obtained of the performance of the flock for any particular year. This method also serves to evaluate the milk yield of each registered ewe in relation to the average milk yield of the flock. This frequency distribution also forms the basis for comparing the economic performance of the flocks. In ewes obtaining about 60% of their food on natural pastures, the influence of prevailing conditions is very strong; it often happens that in unfavourable years a ewe of previously proved high milk producing capacity drops considerably in her production due to bad environmental conditions. As the same conditions affect all the ewes of the flock, the percentage figures of milk production in relation to the flock average usually show smaller fluctuations between different years.

Nevertheless, this distribution of the annual milk yield is unsuitable for selection purposes. Ewes which suffered from indisposition, unnoticed by the shepherd in a flock of several hundred, will fall into a lower category. Ewes which were barren and did not produce milk in that particular year do not appear in this distribution.

In order to avoid doubts caused by these and similar reasons, a special frequency distribution of the flock is prepared for selection purposes.

(b) *The breeding standard yield*

Here, the ewes are grouped according to their maximum lactation yield. Moreover, first lactations are accentuated in order to avoid premature culling of ewes which are not yet in their full productive capacity. All ewes to be retained for breeding in the coming mating season appear in this distribution. Under the conditions prevailing in our flocks, where no special treatment with regard to feeding and management is given to individual ewes and where all ewes are treated alike, all those reaching high milk yields are considered able to produce the same results under corresponding environmental conditions. A ewe which reached a high category remains there until she improves on her performance, but she is not relegated to a lower category even though her milk yield decreases in later years. For selection purposes the ewe has given proof of her productive capacity, provided the milk recording in the flock was done correctly. This distribution gives a clear picture of the quality of the flock; the average of all the maximum milk yields, calculated statistically, is called the breeding standard of the flock. Both average figures are then communicated to shepherds in charge of flocks.

Each shepherd is now able to proceed with culling and with selecting individual ewes for breeding. He decides how many ewes to cull either for reasons of low production or of advanced age. In order to replace the culls with young

ewes bred in his own flock, he has to mark twice as many of his best dams, bearing in mind that only half of the offspring will be females. To this he adds about 25% in order to provide for late lambing, barrenness, abortion, death and weak condition of lambs. At the same time, he tries not to go below the breeding standard of the flock in order to ensure its steady improvement. The marked ewes will be put to the best rams, and the shepherd will take the trouble of finding all the available information about milk production of other members of the same family. Working on these lines for several consecutive years he has a chance of improving the quality of his flock; this has actually been done in the outstanding flocks in the country. The Ginegar flock, for instance, does not keep any adult ewes which have not reached the 300 kg category, and does not rear female lambs for retention whose dams have a breeding standard below 450 kg of milk. All other female lambs are sold to other flocks, although they are very good breeding stock.

All flocks keeping milk records send copies of both these sheets of frequency distributions to the Flock Book management. If a flock omits this for two consecutive years, it is struck off the Flock Book, in compliance with a decision of the General Assembly of the Sheep-breeders' Association.

When all returns have been collected, the average annual yield for all recorded ewes is calculated. The same is done with the second frequency distribution (maximum yields) and this gives an average indicating the breeding value of all ewes in the flocks attached to the Flock Book. The first average is the milk yield actually achieved in a particular year, whereas the second figure is an approximate indication of the potential milk production which could be reached under favourable conditions.

The difference between the two figures, smaller in good and greater in bad years, varies to some extent with the prevailing general conditions of grazing and feeding. Moreover, this difference serves as a pointer to the sort of management in each flock. Table XXIX contains the data for a period of four years. For instance, the average annual milk yield of 18,911 ewes from 92 flocks was 219.54 kg, for 1953/54. In the same year, the average for maximum yields of 19,302 ewes from 96 flocks was 248.27 kg, the difference of about 29 kg being the average for all recorded ewes. If a flock showed a difference considerably exceeding 29 kg between its average milk yield and its breeding standard, and if no other reasons could be traced, this indicates that faulty management prevented the ewes from fully developing their milk producing capacity. In some cases, however, it has been found that the difference was caused by disease which befell the whole flock or its greater part, during the milking season.

The Flock Book management, which is primarily concerned with selection and breeding on a country wide scale, bases its entire work on the frequency distribution, listing the ewes according to their value for breeding purposes.

TABLE XXIX

Difference between annual and breeding standard yield

Year	Annual milk yield			Breeding standard yield			Difference between both yields
	Recorded		M	Recorded		M	
	Flocks	Ewes	kg	Flocks	Ewes	kg	kg
1951—52	64	13,245	214.72	75	15,178	238.79	24.07
1952—53	82	17,120	210.07	88	18,522	239.92	29.85
1953—54	92	18,911	219.54	96	19,302	248.27	28.73
1955—56	104	22,773	255.42	109	22,519	280.23	24.81

The flocks are arranged in the order of their breeding standard and this information is presented to the annual general assembly of the Sheep-breeders' Association. The tables form a permanent record, showing the ups and downs of each flock in the Flock Book. The shepherds naturally compare the results of their own flock with those of the other flocks from the same geographical region. This leads to a valuable exchange of views and readily given mutual help. The 1st and 14th annual reports of the Flock Book are reproduced in Tables XXX and XXXI.

The Flock Book management analyses the quality of each flock by dividing the ewes into groups at intervals of 50 kg milk yield, and stating their absolute number as well as the percentage of each group in relation to the total number of ewes in the flock. Ewes with a milk yield exceeding 350 kg are eligible for registration in the Flock Book. Their ear numbers are checked and their shepherds are requested to supply an exact copy of their Sheep Shed Card for rechecking. A commission, consisting of the Flock Book manager and the chief instructor for sheep-breeding, examines each ewe, takes the body measurements and allocates the appropriate number of points for body conformation. Then the ewe may be registered in the Flock Book. There is no need to reexamine it for the rest of its life in the flock, as all the required data are recorded in its Flock Book Card (vide Figure 27).

To the Flock Book Card is attached the card received from the shepherd; thus, all the details known of a ewe are collected in the Flock Book. The records are, of course, kept up to date. Additional data are reported to the Flock Book management, on special forms, at the end of the milking season. Complicated as this procedure may look, it is easily performed by one person, because the ewe's records are compiled only once a year.

TABLE XXX

1st Flock Book report: 1942—43

Normal print — absolute figures; bold — percentages

Classification number	Flock	Ewes milk recorded	Milk yield in kg Annual	Breeding standard	Record	Ewes registered	100	150	200	250	300	350	400	450
1	Beit Zera	141	195.36	221.06	330	47	3	9	30	52	33	14		
						33.33	**2.13**	**6.38**	**21.28**	**36.88**	**23.40**	**9.93**		
2	Geva	135	184.35	219.56	350	44	4	7	26	54	34	9	1	
						32.66	**2.96**	**5.19**	**19.26**	**39.93**	**25.26**	**6.67**	**0.73**	
3	Ein Harod	284	204.43	218.74	430	105	15	25	54	85	73	25	5	2
						36.97	**5.28**	**8.80**	**19.37**	**29.58**	**25.71**	**8.80**	**1.76**	**0.70**
4	Afikim	159	175.87	192.89	380	23	11	16	53	56	17	5	1	
						14.46	**6.92**	**10.06**	**33.34**	**35.22**	**10.69**	**3.14**	**0.63**	
5	Merhavia	227	162.56	184.23	390	28	14	44	78	63	23	4	1	
						12.33	**6.17**	**19.38**	**34.37**	**27.75**	**10.13**	**1.76**	**0.44**	
6	Ginegar	213	155.54	175.68	320	16	15	39	77	66	15	1		
						7.51	**7.04**	**18.31**	**36.16**	**30.98**	**7.04**	**0.47**		
7	Ein Hamifratz	153	166.16	173.46	330	15	1	48	53	36	12	3		
						9.80	**0.65**	**31.37**	**34.65**	**23.53**	**7.84**	**1.96**		
8	Sarid	185	153.96	172.59	310	13	5	52	70	45	11	2		
						7.03	**2.70**	**28.11**	**37.84**	**24.32**	**5.95**	**1.08**		
9	Ein Geb	123	160.00	171.21	380	14	18	28	32	31	11	2	1	
						11.38	**14.63**	**22.77**	**26.02**	**25.20**	**8.94**	**1.63**	**0.81**	
10	Beit Hashitta	162	161.79	163.39	360	12	16	46	59	29	9	2	1	
						7.40	**9.88**	**28.39**	**36.43**	**17.90**	**5.55**	**1.23**	**0.62**	
11	Usha	143	154.41	159.80	290	7	15	37	58	26	7			
						4.90	**10.49**	**25.87**	**40.56**	**18.18**	**4.90**			
12	Misra	186	145.00	159.68	310	8	13	67	66	32	6	2		
						4.31	**6.99**	**36.02**	**35.48**	**17.20**	**3.23**	**1.08**		
13	Tel Yosef	208	143.64	157.70	300	16	32	64	63	33	15	1		
						7.69	**15.38**	**30.76**	**30.54**	**15.81**	**7.21**	**0.48**		
14	Mikveh Israel	101	145.46	149.80	320	14	30	20	21	16	11	3		
						13.86	**29.70**	**19.80**	**20.80**	**15.84**	**10.89**	**2.97**		
	Total	2,420	169.43	181.60	430	362	192	502	740	624	277	73	10	2
						14.96	**7.93**	**20.75**	**30.58**	**25.78**	**11.45**	**3.02**	**0.41**	**0.08**

TABLE XXXI

14th Flock Book report: 1955—56

Normal print — absolute figures; bold — percentages

Classification No.	Flock	Ewes milk recorded	Milk yield in kg Annual	Breeding Standard	Record	Ewes registered	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
1—11	The 11 best flocks*	2,593	359.08	397.05	890	1,855	2	4	24	70	200	438	563	571	368	201	96	38	9	4	3	1	1
						66.72	**0.08**	**0.15**	**0.92**	**2.70**	**7.71**	**16.89**	**21.71**	**22.02**	**14.19**	**7.75**	**3.73**	**1.46**	**0.35**	**0.15**	**0.11**	**0.04**	**0.04**
12	Mahanaim	193	321.41	334.30	560	82		2	3	11	41	54	49	21	6	4	2						
						42.49		**1.04**	**1.55**	**5.70**	**21.24**	**27.98**	**25.39**	**10.88**	**3.11**	**2.07**	**1.04**						
13	Kfar Szold	248	**	332.42	560	106			1	20	51	70	68	27	10		1						
						42.74			**0.40**	**8.06**	**20.57**	**28.23**	**27.42**	**10.89**	**4.03**		**0.40**						
14	Hulda	283	295.74	328.34	530	99			5	11	73	95	66	22	9	2							
						34.98			**1.77**	**3.89**	**25.79**	**33.57**	**23.32**	**7.77**	**3.18**	**0.71**							
15	Tel Yosef	268	272.72	327.35	560	122	5	6	15	24	48	48	53	40	20	6	3						
						45.53	**1.86**	**2.24**	**5.60**	**8.95**	**17.91**	**17.91**	**19.78**	**14.93**	**7.46**	**2.24**	**1.12**						
16	Moledet	251	297.23	322.15	680	74			2	19	78	78	38	21	10	3	1		1				
						29.48			**0.80**	**7.57**	**31.07**	**31.07**	**15.14**	**8.37**	**3.98**	**1.20**	**0.40**		**0.40**				
17	Urim	205	289.71	318.29	600	67		1	4	33	51	49	30	20	12	3	1	1					
						32.68		**0.49**	**1.95**	**16.10**	**24.88**	**23.90**	**14.63**	**9.76**	**5.85**	**1.46**	**0.49**	**0.49**					
18	Sde Nahum	307	290.00	317.88	580	102		4	7	27	69	98	67	25	8	1	1						
						33.23		**1.30**	**2.28**	**8.79**	**22.48**	**31.92**	**21.82**	**8.14**	**2.61**	**0.33**	**0.33**						
19	Dorot ***	322	313.04	317.64	560	119	1	5	14	37	68	78	71	36	10	1	1						
						36.95	**0.31**	**1.55**	**4.35**	**11.49**	**21.12**	**24.23**	**22,05**	**11.18**	**3.10**	**0.31**	**0.31**						
20	Dalia	246	303.40	316.38	470	77			3	27	54	85	57	15	5								
						31.30			**1.22**	**10.98**	**21.95**	**34.55**	**23.17**	**6.10**	**2.03**								
21	Yagur	185	292.12	315.46	530	58		3	5	16	39	64	35	19	2	2							
						31.35		**1.62**	**2.70**	**8.65**	**21.08**	**34.60**	**18.92**	**10.27**	**1.08**	**1.08**							
22	Magen	180	317.29	315.45	520	58			1	24	49	48	34	19	4	1							
						32.22			**0.56**	**13.33**	**27.22**	**26.67**	**18.89**	**10.55**	**2.22**	**0.56**							
23	Jezreel	221	304.75	310.72	550	71		4	17	24	48	57	40	13	15	2	1						
						32.13		**1.81**	**7.69**	**10.86**	**21.72**	**25.79**	**18.10**	**5.89**	**6.79**	**0.90**	**0.45**						
24	Dovrat	202	281 67	309.85	550	60		4	12	20	51	55	39	10	5	4	2						
						29.70		**1.98**	**5.94**	**9.90**	**25.25**	**27.23**	**19.31**	**4.85**	**2.47**	**1.98**	**0.99**						
25	Alonim	205	292.91	307.27	500	39				21	67	78	27	10	1	1							
						19 03				**10.24**	**32.68**	**38.05**	**13.17**	**4.88**	**0.49**	**0.49**							

26	Kabri	200	283.23	306.30	470	43		2	7	20	63	65	20	20	3		
						21.50		1.00	3.50	10.00	31.50	32.50	10.00	10.00	1.50		
27	Gezer	206	261.26	306.26	460	49	2	3	9	17	39	87	34	13	2		
						23.79	0.97	1.46	4.37	8.25	18.93	42.23	16.51	6.31	0.97		
28	Na'an	206	271.26	304.66	570	58		1	14	35	44	54	31	17	7	2	1
						28.15		0.48	6.80	16.99	21.36	26.22	15.05	8.25	3.40	0.97	0.48
29	Giv'at Brenner	245	248.89	303.18	530	63	1	6	8	27	61	79	42	18	2	1	
						25.71	0.41	2.45	3.27	11.02	24.90	32.24	17.14	7.34	0.82	0.41	
30	Hadassim	116	274.82	299.31	450	30			5	21	31	29	19	10	1		
						25.86			4.31	18.10	26.73	25.00	16.38	8.62	0.86		
31	Beit Alfa	202	277.75	297.97	530	55		1	14	44	39	49	34	13	6	2	
						27.23		0.49	6.93	21.78	19,31	24.26	16.83	6.44	2.97	0.99	
32	Nitsanim	174	280.44	296.67	520	39		1	7	28	50	49	29	4	5	1	
						22.42		0.58	4.02	16.09	28.73	28.16	16.67	2.30	2.87	0.58	
33	Regavim	173	**	296.30	570	39			10	34	46	44	19	12	5	2	1
						22.55			5.78	19,65	26.59	25.43	10.98	6.94	2.89	1.16	0.58
34	Kfar Menahem	267	245.03	295.54	510	63	1	7	14	38	62	82	47	12	3	1	
						23.60	0.38	2.62	5.24	14.23	23.22	30.71	17.60	4.50	1.12	0.38	
35	Ashdot Ya'aqov	202	255.88	294.45	470	44		1	10	31	63	53	33	10	1		
						21.78		0.49	4.95	15.35	31.19	26.24	16.34	4.95	0.49		
36	Hulata	178	**	287.87	430	32		1	10	27	58	50	28	4			
						17.98		0.56	5.62	15.17	32.58	28.09	15.73	2.25			
37	Ein Dor	240	258.80	287.04	500	38	3	7	17	21	74	80	25	10	2	1	
						15.84	1.25	2.92	7.08	8.75	30.83	33.33	10.42	4.17	0.83	0.42	
38	Tsiklag	179	252.38	283.97	500	28		4	7	41	56	43	18	7	2	1	
						15.65		2.22	3.91	22.91	31.29	24.02	10.06	3.91	1.12	0.56	
39	Evron	201	259.09	283.53	460	38		3	20	30	59	51	28	9	1		
						18.91		1.49	9.95	14.93	29.35	25.37	13.93	4.48	0.50		
40	Negba	235	258.63	282.73	450	41		2	18	49	66	59	34	6	1		
						17.45		0.85	7.66	20.85	28.08	25.11	14.47	2.55	0.43		
41	Sha'alavim	191	265.82	282.25	510	31		2	13	40	64	41	24	5	1	1	
						16.22		1.05	6.81	20.94	33.51	21.47	12.56	2.62	0.52	0.52	
42	Sasa	176	279.94	282.22	460	29		4	11	36	52	44	23	4	2		
						16.48		2.27	6.25	20.45	29.55	25.00	13.07	2.27	1.14		

* For particulars see Table XXXIV
** Results from 1954—55
*** All ewes two years old

TABLE XXXI (continued)

14th Flock Book report : 1955 — 56

Normal print — absolute figures; bold — percentages

Classification No.	Flock	Ewes milk recorded	Milk yield in kg Annual	Breeding Standard	Record	Ewes registered	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
43	Timurim	184	262.57	281.74	460	25			9	41	60	49	21	3	1								
						13.59			**4.89**	**22.28**	**32.61**	**26.63**	**11.42**	**1.63**	**0.54**								
44	Ben Shemen	151	267.32	280.46	460	25			11	35	47	33	17	7	1								
						16.56			**7.28**	**23.18**	**31.13**	**21.85**	**11.26**	**4.64**	**0.66**								
45	Talmei Elazar	103	252.37	278.35	410	13			3	21	46	20	11	2									
						12.62			**2.91**	**20.39**	**44.66**	**19.42**	**10.68**	**1.94**									
46	Hamadia	226	249.46	278.05	450	31	1	5	21	40	65	63	23	7	1								
						13.72	**0.44**	**2.21**	**9.29**	**17.70**	**28.76**	**27.88**	**10.18**	**3.10**	**0.44**								
47	Hatsor	210	213.69	277.43	470	35	2	8	23	33	55	54	23	8	4								
						16.66	**0.95**	**3.81**	**10.95**	**15.72**	**26.19**	**25.72**	**10.95**	**3.81**	**1.90**								
48	Kadoori	87	249.76	272.99	440	8		1	3	29	29	17	6	2									
						9.20		**1.15**	**3.45**	**33.33**	**33.33**	**19.54**	**6.90**	**2.30**									
49	Giv'at Oz	190	255.65	271.79	490	19			14	43	75	39	16	2	1								
						10.00			**7.37**	**22.63**	**39.47**	**20.53**	**8.42**	**1.05**	**0.53**								
50	Heftsi-Bah	157	234.76	271.34	440	21		4	11	42	48	31	13	8									
						13.38		**2.55**	**7.00**	**26.75**	**30.57**	**19.75**	**8.28**	**5.10**									
51	Ein Hahoresh***	161	239.12	270.81	590	23		1	20	41	50	26	11	8	2	1	1						
						14.28		**0.62**	**12.42**	**25.47**	**31.06**	**16.15**	**6.83**	**4.97**	**1.24**	**0.62**	**0.62**						
52	Nahshon	222	225.74	269.91	510	34	2	11	17	56	59	43	23	5	5	1							
						15.31	**0.90**	**4.95**	**7.66**	**25.23**	**26.58**	**19.37**	**10.36**	**2.25**	**2.25**	**0.45**							
53	Beit Keshet	227	253.67	266.65	480	23		3	20	61	78	42	16	5	2								
						10.14		**1.32**	**8.81**	**26.87**	**34.36**	**18.50**	**7.05**	**2.21**	**0.88**								
54	Ma'abarot	261	221.89	265.40	500	38	6	11	37	47	69	53	31	4	1	2							
						14.55	**2.30**	**4.21**	**14.18**	**18.01**	**26.44**	**20.31**	**11.88**	**1.53**	**0.38**	**0.76**							
55	Yiftah	175	227.31	264.12	440	17		10	25	31	41	51	9	8									
						9.71		**5.71**	**14.29**	**17.72**	**23.43**	**29.14**	**5.14**	**4.57**									
56	Gal-On	225	253.78	262.76	460	23	1	6	23	58	71	43	13	8	2								
						10.22	**0.45**	**2.66**	**10.22**	**25.78**	**31.56**	**19.11**	**5.78**	**3.55**	**0.89**								
57	Alumot	263	255.00	262.43	480	26	2	12	24	68	79	52	21	3	2								
						9.88	**0.76**	**4.56**	**9.13**	**25.86**	**30.04**	**19.77**	**7.98**	**1.14**	**0.76**								
58	Revadim	217	221.85	261.89	540	18	3	13	20	41	67	55	15	2		1							
						8.29	**1.38**	**5.99**	**9.22**	**18.89**	**30.88**	**25.35**	**6.91**	**0.92**		**0.46**							
59	Sa'ad	222	228.59	260.22	500	31	8	6	31	54	53	39	21	5	4	1							
						13.96	**3.60**	**2.70**	**13.96**	**24.33**	**23.88**	**17.57**	**9.46**	**2.25**	**1.80**	**0.45**							

60	Gvat	270	226.70	257.18	450	31	4	17	33	64	70	51	22	8	1
						11.48	1.48	6.30	12.22	23.70	25.93	18.89	8.15	2.96	0.37
61	Hahotrim	201	242.52	256.92	420	23	2	7	30	45	54	40	22	1	
						11.44	1.00	3.48	14.92	22.39	26.87	19.90	10.94	0.50	
62	Misra	250	228.57	255.84	460	22	6	15	22	60	81	44	17	4	1
						8.80	2.40	6.00	8.80	24.00	32.40	17.60	6.80	1.60	0.40
63	Harel	250	230.08	253.44	480	20	2	9	33	70	77	39	15	2	3
						8.00	0.80	3.60	13.20	28.00	30.80	15.60	6.00	0.80	1.20
64	Kfar Hanassi	253	229.53	253.00	440	26		9	41	76	73	28	21	5	
						10.28		3.56	16.20	30.04	28.85	11.07	8.30	1.98	
65	Megiddo	218	231.85	252.66	490	14	2	8	19	68	77	30	10	2	2
						6.43	0.92	3.67	8.71	31.19	35.32	13.76	4.59	0.92	0.92
66	Kfar Aza	176	251.42	251.42	450	23	4	18	28	34	38	31	20	2	1
						13.07	2.27	10.23	15.91	19.32	21.59	17.61	11.36	1.14	0.57
67	Maoz Haim	184	226.61	250.87	380	10		2	24	65	59	24	10		
						5.43		1.09	13.04	35.33	32.07	13.04	5.43		
68	Merhavia	224	239.95	249.91	400	6		5	38	61	70	44	4	2	
						2.68		2.23	16.97	27.23	31.25	19.64	1.79	0.89	
69	Akko	120	223.59	249.50	440	6	2	3	16	33	43	17	5	1	
						5.00	1.66	2.51	13.33	27.50	35.83	14.17	4.17	0.83	
70	Nahalal	144	229.67	248.61	420	5		3	15	61	40	20	4	1	
						3.47		2.08	10.41	42.37	27.78	13.89	2.78	0.69	
71	Mishmar David	193	231.00	248.45	450	16	3	9	29	52	52	32	10	4	2
						8.29	1.55	4.67	15.03	26.94	26.94	16.58	5.18	2.07	1.04
72	Netiv	222	239.38	247.43	400	14	5	7	31	62	63	40	13	1	
	Halamedhe					6.31	2.25	3.15	13.96	27.93	28.38	18.02	5.86	0.45	
73	Shavei Zion	187	232.33	247.33	460	14	4	10	30	49	45	35	9	4	1
						7.49	2.14	5.35	16.04	26.20	24.06	18.72	4.81	2.14	0.54
74	Arbel	304	237.67	247.24	460	15	5	15	37	89	93	50	11	1	3
						4.94	1.64	4.93	12.17	29.28	30.59	16.45	3.62	0.33	0.99
75	Hasolelim	137	237.09	246.94	430	6	2	6	12	47	47	17	3	3	
						4.38	1.46	4.38	8.76	34.31	34.31	12.40	2.19	2.19	
76	Gazit	162	224.59	245.43	380	4	1	4	20	49	67	17	4		
						2.47	0.62	2.47	12.34	30.25	41.36	10.49	2.47		

* For particulars see Table XXXIV

** Results from 1954—55

*** All ewes two years old

Normal print — absolute figures; bold — percentages

TABLE XXXI (continued)

14th Flock Book report : 1955 — 56

Classification No.	Flock	Ewes milk recorded	Milk yield in kg Annual	Breeding Standard	Record	Ewes registered	100	150	200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
77	Mishmar Ha'emek	196	222.07	243.72	430	10	2	6	29	64	58	27	9	1									
						5.10	**1.02**	**3.06**	**14.80**	**32.65**	**29.59**	**13.78**	**4.59**	**0.51**									
78	Erez	190	228.32	242.79	540	20	11	13	30	38	54	24	13	3	1	3							
						10.53	**5.79**	**6.84**	**15.79**	**20.00**	**28.42**	**12.63**	**6.84**	**1.58**	**0.53**	**1.58**							
79	Hazorea	267	219.00	242.66	470	9	10	13	40	60	84	51	6	1	2								
						3.37	**3.74**	**4.87**	**14.98**	**22.48**	**31.46**	**19.10**	**2.25**	**0.37**	**0.75**								
80	Bar'am	217	215.49	242.35	390	3		4	23	91	71	25	3										
						1.38		**1.84**	**10.60**	**41.94**	**32.72**	**11.52**	**1.38**										
81	Ruhama ***	174	241.21	241.21	410	7	3	4	36	55	37	32	6	1									
						4.03	**1.72**	**2.30**	**20.69**	**31.61**	**21.26**	**18.39**	**3.45**	**0.58**									
82	Nahlot	225	218.31	240.98	490	10	1	15	34	69	68	28	8	1	1								
						4.44	**0.44**	**6.67**	**15.11**	**30.67**	**30.22**	**12.45**	**3.56**	**0.44**	**0.44**								
83	Afek	159	207.56	240.50	440	6	6	11	17	54	44	21	3	3									
						3.78	**3.77**	**6.92**	**10.69**	**33.96**	**27.67**	**13.21**	**1.89**	**1.89**									
84	Gal-Ed	259	**	240.23	450	7		13	35	89	89	26	4	2	1								
						2.70		**5.02**	**13.52**	**34.36**	**34.36**	**10.04**	**1.54**	**0.77**	**0.39**								
85	Ma'ayan Barukh	142	194.87	237.60	390	8	3	5	32	37	40	17	8										
						5.63	**2.11**	**3.52**	**22.54**	**26.06**	**28.17**	**11.97**	**5.63**										
86	Kfar Habonim	185	225.82	236.22	420	4	2	9	26	67	56	21	3	1									
						2.16	**1.08**	**4.87**	**14.05**	**36.22**	**30.27**	**11.35**	**1.62**	**0.54**									
87	Beit Govrin	156	236.22	236.22	410	7	4	11	24	54	33	23	4	3									
						4.48	**2.56**	**7.05**	**15.39**	**34.62**	**21.16**	**14.74**	**2.56**	**1.92**									
88	Shomrat	180	209.83	234.83	410	7	4	16	27	46	61	19	6	1									
						3.88	**2.22**	**8.89**	**15.00**	**25.56**	**33.89**	**10.56**	**3.33**	**0.55**									
89	Alonei Abba	178	219.24	233.31	430	7	2	13	29	63	54	19	5	2									
						3.93	**1.12**	**7.31**	**16.29**	**35.39**	**25.28**	**10.68**	**2.81**	**1.12**									
90	Ramot Menashe	281	210.49	232.38	460	5	7	11	47	95	93	23	4		1								
						1.78	**2.49**	**3.91**	**16.73**	**33.81**	**33.10**	**8.18**	**1.42**		**0.36**								
91	Rosh Hanikra	121	223.82	232.06	420	5	1	14	14	40	34	13	3	2									
						4.13	**0.83**	**11.57**	**11.57**	**33.06**	**28.10**	**10.74**	**2.48**	**1.65**									
92	Nahshonim	170	225.30	229.75	380	6	3	9	34	50	53	15	6										
						3.53	**1.77**	**5.29**	**20.00**	**29.41**	**31.18**	**8.82**	**3.53**										
93	Ein Gev	213	198.91	229.67	410	6	10	17	40	55	58	27	3	3									
						2.82	**4.69**	**7.98**	**18.78**	**25.82**	**27.23**	**12.68**	**1.41**	**1.41**									

94	Ein Shemer	197	209.84	229.65	410	17	20	15	30	49	45	21	12	5									
						8.63	10.15	7.62	15.23	24.87	22.84	10.66	6.09	2.54									
95	Amiad	182	205.80	228.46	480	13	6	18	38	49	43	15	7	4	2								
						7.15	3.30	9.89	20.88	26.92	23.62	8.24	3.85	2.20	1.10								
96	Affula	158	217.67	226.52	380	3	4	9	30	58	41	13	3										
						1.90	2.53	5.69	18.99	36.71	25.95	8.23	1.90										
97	Ein Hamifratz	231	183.01	224.81	460	13	9	22	58	50	55	24	8	3	2								
						5.63	3.90	9.52	25.11	21.64	23.81	10.39	3.46	1.30	0.87								
98	Yassur	217	204.13	224.56	360	2	9	18	32	71	69	16	2										
						0.92	4.15	8.30	14.75	32.71	31.80	7.37	0.92										
99	Gonen	207	210.27	222.08	410	7	1	19	58	58	43	21	6	1									
						3.38	0.48	9.18	28.02	28.02	20.77	10.15	2.90	0.48									
100	Nir Etsion	173	212.82	221.27	400	3	2	16	40	59	35	18	1	2									
						1.74	1.16	9.24	23.12	34.11	20.23	10.40	0.58	1.16									
101	Bitsaron	104	218.46	218.46	400	11	3	19	30	15	15	11	8	3									
						10.58	2.89	18.27	28.84	14.42	14.42	10.58	7.69	2.89									
102	Yaron	233	197.40	216.94	400	3	8	13	54	97	44	14	2	1									
						1.29	3.43	5.58	23.18	41.63	18.88	6.01	0.86	0.43									
103	Kfar Hittim	276	203.82	216.27	440	4	16	23	55	94	63	21	2	2									
						1.44	5.80	8.33	19.93	34.06	22.83	7.61	0.72	0.72									
104	Lavie	196	191.53	212.65	390	3	1	9	70	70	35	8	3										
						1.53	0.51	4.89	35.72	35.72	17.85	4.08	1.53										
105	Hakuk	214	193.19	210.19	380	1	5	15	76	63	39	15	1										
						0.47	2.34	7.01	35.51	29.44	18.22	7.01	0.47										
106	Ayelet Hashahar	123	**	205.77	370	1	9	8	32	40	28	5	1										
						0.81	7.32	6.50	26.02	32.52	22.76	4.07	0.81										
107	Neve Eitan***	141	204.68	204.68	380	2	2	13	48	49	25	2	2										
						1.42	1.42	9.22	34.04	34.75	17.73	1.42	1.42										
108	Shamir	256	161.40	202.46	370	4	18	34	54	92	41	13	4										
						1.56	7.03	13.28	21.09	35.94	16.02	5.08	1.56										
109	Barkai	222	178.80	200.76	360	1	16	29	62	65	28	21	1										
						0.45	7.21	13.06	27.93	29.28	12.61	9.46	0.45										
	Total	22,519	255.42	280.23	890	4,589	280	780	2,361	4,655	5,582	4,272	23.72	1,216	579	252	112	39	10	4	3	1	1
						20.37	1.24	3.48	10.48	20.67	24.79	18.97	10.53	5.40	2.57	1.12	0.50	0.17	0.04	0.02	0.01	0.005	0.005

* For particulars see Table XXXIV

** Results from 1954—55

*** All ewes two years old

SHEEP BREEDERS ASSOCIATION
in Israel

EWE'S CARD

FLOCK BOOK MANAGEMENT
for Improved Awassi Sheep
in Israel

7513 Ewe's Flock Book No

14.VI.54 Registered on

Ein Harod (Ichud) Farm

596B Ewe's No. (ear mark No.)

Ein Harod at 24.XII.49 Born on

brown spots body brown Head

PEDIGREE

440B/3739 Dam 2.6 ; 414 kg Milk production 18 Points for body conformation				259 : NASICH Sire 428 kg Index for milk production 24 Points for body conformation			
-/- Dam Milk production		-/- Sire Index for milk production		485/104 Dam Milk production 3.5 ; 564 kg		2 : Chagay Sire Index for milk production 369 kg	
Points for body conformation				Points for body conformation 20		24	
Dam Milk production	Sire Index for milk production	Dam Milk production	Sire Index for milk production	197 Dam Milk production 202 kg	Arich 3 Sire Index for milk production 413 kg	130 Dam Milk production 212 kg 1.8	Gibeah 1 Sire Index for milk production 283 kg
Points for body conformation				Points for body conformation	18		/

BODY MEASUREMENTS

100.00 - 76	Height at withers
101.3 - 77	Height at back
102.6 - 78	Height at crupper
27.5 - 21	Breadth of chest
44.7 - 34	Deapth of chest
126.3 - 96	Chest circumference
30.3 - 23	Breadth of pelvis
109.2 - 83	Length of body
10.5 - 8	Shin bone circumference
65	Weight

X

MILK PRODUCTION

Remarks	Butter-fat in %	in % of flock's average	Flock's average	Suckling period		Date of		Daily max.	Full lactation		Year
				daily increase	days	abortion	lambing		Days	Yield	
Precocious lambing		–	277.20	–	24		9.II.51	2.3	152	296	50-51
		+134%	259.06	–	63		24.XII.51	3.7	223	607	51-52
		–	–	0.216	74		24.III.53	1.4	130	181	52-53
		+35%	345.80	0.298	62		23.XII.53	2.4	225	466	53-54
43.709 kg butterfat	6.0	+77%	405.90	–	65		18.XII.54	4.3	253	719	54-55
55.211 kg butterfat	6.20	+118%	409.32	–	66		14.XII.55	5.5	262	890	55-56

Cause of exit

Left flock on

Figure 27a
Flock Book Card (front)

POINT SYSTEM FOR EWE'S CLASSIFICATION

19..	1956	1952	
	10	10	PEDIGREE .1
	30	30	Annual milk yield MILK .2
	8	8	Daily maximum yield
	4	4	Length of lactation
	1	–	Butterfat % in milk
	–	–	Lamb's weight increase per suckling day
	43	42	Total
			WOOL PRODUCTION .3
	4	4	Height BODY .4
	4	4	Length
	3	3	Chest development
	2	2	Shin bone development
	5	5	Udder development
	5	5	General impression
	23	23	Total
	5	5	Health HEALTH .5
	5	5	Fertility
	10	10	Total
	86	85	Grand total

REMARKS

PROGENY

SONS								DAUGHTERS						
Reg. daughters			Points body conf.	Farm (owner)	Sire No.	Born on	Flock Book No.	Points for body conf.	Points for milk yield	Flock Book No.	Farm (owner)	Sire No.	Born on	Ear mark No.
No.	No.	No.												
				Ein Harod	–	23.XII 53					Ein Harod.	Aharon	18.XII.54	193
											Ein Harod	Ger	14.XII.55	375

Figure 27b
Flook Book Card (reverse)

SHEEP BREEDERS ASSOCIATION IN ISRAEL

FLOCK BOOK MANAGEMENT

(1954 Year) AA :Class RAM CERTIFICATE

(.......... ")..........: "

........../ Ginegar...... Farm

........../ 14 Certificate No.

1020 : Flock Book No. 0792 Ham Name & No.

25 Points for body : conformation Ein Harod : Breeder 30.XI.51 : Born on

.... Total classification points Heavy horned Special signs white, head brown Colour

PEDIGREE

722/791 Dam Milk production 46-47: 474 kg; 2.9 (3) 47-48: 457 kg; 2.8 (4) 48-49: 533 kg; 3.3 (5) 21 Points for body conformation				259 NASICH Sire 428 kg CHECKED 24 Points for body conformation			
341 Dam % Milk production		Chsen Sire		485/104 Dam Milk production 46-47: 564 kg; 3.5 (5) 47-48: 442 kg; 3.0 (6) 48-49: 486 kg; 3.0 (7) 20		2 Chagay Sire 369 kg CHECKED 24	
Points for body conformation				Points for body conformation			
158 Dam Milk production	Sire Zizik 1 283 kg CHECKED	% Dam Milk production	% Sire	197 Dam Milk production 202 kg	Sire Arieh 3 413 kg CHECKED	130 Dam Milk production 212 kg 1.8	Sire Zizik 1 283 kg CHECKED
Points for body conformation				Points for body conformation			
	%			%	18		%

.... Remarks

..........:Date ....: 1 Transferred to

.... " ....: 2

.... " ....: 3

..........: Cause / .... Left flock on

Flock Book Manager 25 June 1953. Date

Figure 28
Ram Certificate

39. The improvement of milk production

The gradual improvement of milk production in the Awassi may be learned from three sources: (a) by concentrating on a limited number of flocks (the 11 best flocks in the country); (b) by studying the country wide improvement as reflected in the annual reports of the Flock Book management (Flock Book records); (c) by following the gradual development of two outstanding flocks, those of Ein Harod and Geva.

(a) The 11 best flocks in the country

The author, on his immigration into Palestine in 1937, was employed by the Jewish Agency as instructor in sheep-breeding. His first task was to visit the 38 flocks then in Jewish settlements, and to report on their condition to the Settlement Department of the Agency.

Milk recording was practiced in 1937 only in 11 flocks, with reliable records being available from 975 ewes. The latter's performance in the 1937—38 milking season was tabulated and these 11 flocks were then regarded as the best in the country. A comparison of these 11 flocks with the 11 best flocks of later years, for which records are available, illustrates the improvement made after 18 years of work. The relevant data are given in Table XXXII(a). In 1937—38 only 6 ewes (0.62% of the recorded ewes) yielded over 250 kg of milk. The maximum was 290 kg, whilst the average of the 975 controlled ewes was 130.95 kg.

In the 11 best flocks of 1955—56, 1,292 ewes (about 50% of the total) exceeded 400 kg of milk. The maximum was 890 kg, while the breeding standard yield amounted to 397 kg. Compared to the records of 1937—38, there is an increase of 266 kg (over 200%) in the average milk yield. The figures show that the increase continued steadily up to the 1948—49 milking season. In the first ten years the breeding standard yield increased by 174 kg (133%). The increase slowed down since 1948—49, and the breeding standard yield appeared stabilized up to 1951—52, followed by a moderate rise in the next two years.

The figures for 1954—55, however, show an unusual increase of 44 kg (over 13%) over the preceding year. As this fact was noticed in most of the better flocks, it was obviously due to the recently introduced method of milk recording. In order to find the magnitude of this factor, the results from two previous investigations were recalculated as follows:

We see from Table XXVII that the amount of milk suckled by the lamb was underestimated by about 32%, according to the old method of standardization of milk yields. This applies, of course, only to the quantity of milk produced during the first 60 days of the lactation period. Table XXVIII gives the amount produced during this period as approximately 39% of the total milk production. Therefore, about 12% of the increase should be attributed

TABLE XXXII
Improvement of the Awassi sheep

Year	Ewes milk recorded	Breeding standard milk yield			Record milk yield	Ewes with milk yields above			
		M	S.E.	S.D.		250 kg		400 kg	
	n	kg	kg	kg	kg	No.	%	No.	%
				(a) The 11 best flocks					
1937—38	975	130.96	1.4647	45.735	290	6	0.62		
1942—43	1,944	187.86	1.3663	60.235	430	319	16.40	2	0.10
1943—44	2,005	210.27	1.4145	63.334	490	569	28.38	5	0.25
1944—45	1,962	233.13	1.5841	70.163	490	833	42.46	27	1.38
1945—46	2,117	245.70	1.5128	69.603	480	1,071	50.59	30	1.42
1946—47	1.779	270.31	1.7845	75.263	610	1,131	63.58	104	5.84
1947—48	1,941	284.21	1.9305	85.044	650	1,310	67.49	198	10.20
1948—49	2,255	304.51	1.8559	88.131	680	1,692	75.03	350	15.52
1949—50	2,268	305.27	1.7992	85.678	680	1,750	77.16	342	15.08
1950—51	2,442	309.40	1.7239	85.257	650	1,889	77.35	400	16.38
1951—52	2,709	306.76	1.6436	85.547	650	2,120	78.26	406	14.99
1952—53	2,881	314.14	1.5437	82.859	650	2,306	80.05	460	15.97
1953—54	2,713	330.63	1.6620	86.565	650	2,276	83.89	587	21.64
1954—55	2,632	374.46	1.6854	86.466	770	2,493	94.72	1,032	39.21
1955—56	2,593	397.05	1.8252	91.426	890	2,493	96.14	1,292	49.83
				(b) The Ein Harod flock					
1937—38	72	104.38	3.6944	31.348	195				
1939—40	227	175.66	3.0818	46.433	290	17	7.49		
1940—41	241	188.38	3.4028	52.825	310	30	12.45		
1941—42	267	206.39	3.3797	55.225	355	58	21.72		
1942—43	284	218.74	4.1485	69.912	430	105	36.97	2	0.70
1943—44	296	239.05	4.4318	76.249	430	162	54.72	3	1.01
1944—45	305	255.02	4.1115	71.804	480	179	58.69	6	1.97
1945—46	342	258.07	3.9954	73.888	480	204	59.65	7	2.04
1946—47	355	334.42	4.2157	79.429	610	320	90.14	68	19.14
1947—48	423	335.70	4.1425	85.198	610	371	87.71	103	24.32
1948—49	411	375.74	4.2733	86.632	680	392	95.38	160	38.93
1949—50	424	367.74	4.5050	92.762	680	384	90.57	159	37.50
1950—51	522	349.60	4.1777	95.449	610	448	85.82	173	33.14
1951—52	497	338.31	4.1433	92.371	610	422	84.91	136	27.36
				(c) The Geva flock					
1941—42	130	210.65	4.2623	48.602	355	27	20.77		
1942—43	135	219.56	4.7126	54.756	355	44	32.66		
1943—44	170	217.88	3.9979	52.125	355	50	29.41		
1944—45	142	277.82	6.3466	75.626	470	96	67.60	9	6.34
1945—46	146	286.71	5.3020	64.284	440	111	76.02	7	4.79
1946—47	134	326.49	5.5513	64.262	520	119	88.81	18	13 43
1947—48	127	346.22	6.2517	70.451	520	118	92.92	27	21.26
1948—49	161	351.80	5.3688	68.125	520	151	93.79	42	26.08
1949—50	178	363.31	4.7413	63.258	520	172	96.64	56	31.47
1950—51	195	336.46	5 7256	79.953	520	165	84.61	47	24.10
1951—52	164	364.63	5 3036	67.918	520	155	94.51	54	32.92
1952—53	206	374.76	5.4207	77.803	560	193	93.69	86	41.75
1953—54	204	418.78	5.7428	82.025	610	197	96.57	132	64.71
1954—55	208	428.37	5.9499	85.809	640	203	97.60	142	68.27
1955—56	229	434.02	6.4364	97.403	810	218	95.19	164	71.61

to the new method of milk recording. In fact, the percentage is somewhat smaller as not all the ewes actually suckled their lambs for the entire period of 60 days. An estimate of 10% would be more probable, leaving about 3% to show the improvement made in 1954—55.

The figures obtained for 1955—56 can be compared with those of the preceding year, as the identical method was again applied; consequently, we find an increase of about 6%, which is in line with the extent of the upward trend in the general improvement in milk production of the outstanding flocks.

(b) Flock Book records

The Flock Book was established at the end of the 1942—43 milking season, when the special registration of 362 ewes from 14 flocks, with individual milk yields of over 250 kg, was found advisable. It was then decided to register in the Flock Book all ewes producing 250 kg of milk, provided they belonged to a flock with an average yield of 160 kg. This was continued until 1948—49 when the minimum requirement for registration was raised to 275 kg, as a result of an ever increasing number of ewes eligible for registration. The minimum was again raised in 1955—56, to 350 kg, for ewes belonging to flocks with a breeding standard of at least 200 kg.

Table XXXIII gives a condensed summary of the annual reports presented to the general assembly of the Sheep-breeders' Association, which were printed in their organ *Hanoked* (The Sheep-breeder). From 1942—43 to the end of the 1955—56 milking season, both the number of flocks and the milk recorded ewes increased steadily. The number of flocks has risen, during the 13 years, from 14 to 109, and the number of recorded ewes in these flocks from 2,420 to 22,519.

The quality of the stock improved from year to year, as can be seen from the breeding standard, parallel to the average milk yield. Although the inclusion of yearly increasing numbers of ewes in the frequency distribution tended to reduce the average, the improvement continued. In 1949—50 the average decreased to 233.25 kg as against 244.54 kg in the preceding year. This decline was caused by some 3,000 additional ewes included in the calculation. Four years later, in 1953—54, the average climbed to 248.27 kg, despite the impressive number of 19,302 ewes in this calculation. The upward trend continued, although the averages are apparently lower in respect of years when the number of flocks and the number of ewes increased correspondingly.

The unusual rise in 1955—56 from 258 kg to 280 kg was mainly caused by the higher registration standard, which resulted in the exclusion from the Flock Book of 7 flocks with an average yield of less than 200 kg of milk.

Registered ewes in 1942—43, with the then valid standard of 250 kg, numbered only 362 (15% of the total number of ewes); this figure increased to 8,363 (38% of all recorded ewes) in 111 flocks by 1954—55, by which time

TABLE XXXIII

Improvement of the Awassi sheep
(d) The Flock Book records

Year	Flocks in Flock Book	Ewes milk recorded in these flocks	Breeding standard milk yield M kg	S.E. kg	S.D. kg	Record milk yield kg	Ewes registered in Flock Book* No.	%	Ewes with milk yields above 400 kg No.	%
1942—43	14	2,420	181.98	1.2452	61.256	430	362	14.96	2	0.08
1943—44	27	4,337	188.12	0.9344	61.534	490	785	18.11	6	0.13
1944—45	29	4,589	207.53	0.9879	66.925	490	1,244	27.10	30	0.59
1945—46	37	6,093	212.93	0.8987	70.147	490	1,898	31.15	47	0.77
1946—47	38	6,010	227.93	0.9457	73.308	610	2,298	38.24	122	2.03
1947—48	39	6,490	233.33	0.9748	78.534	650	2,639	40.66	219	3.37
1948—49	42	7,866	244.53	0.9387	83.253	680	2,507	31.87	400	5.08
1949—50	57	11,017	233.72	0.7490	78.620	680	2,942	26.70	413	3.74
1950—51	69	13,765	237.68	0.6715	78.784	650	3,933	28.57	521	3.79
1951—52	75	15,178	238.79	0.6339	78.101	650	4,515	29.68	534	3.52
1952—53	88	18,522	239.92	0.5740	78.131	650	5,636	30.43	648	3.50
1953—54	96	19,302	248.27	0.5819	80.848	650	6,679	34.60	883	4.57
1954—55	111	21,849	257.97	0.5693	84.155	770	8,363	38.28	1,457	6.67
1955—56	109	22,519	280.31	0.5837	87.597	890	4,589	20.37	2,217	9.84

* Minimum milk yield required for registration: 1942—43 — 1947—48: 250 kg
1948—49 — 1954—55: 275 kg
1955—56 — : 350 kg

of the registration standard to 350 kg in 1955—56 caused, of course, the sharp decline in the number of registered ewes to 4,589 (20% of the total number of recorded ewes).

The number of ewes in the high milk producing groups reflects the improvement during 13 years. Ewes with over 400 kg of milk were very rare in 1942—43: only 2 (0.08% of all recorded ewes). In 1955—56 there were altogether 2,217 such ewes (9.48% of all recorded ewes). This number includes 422 ewes with over 500 kg of milk. These high producing ewes, which are fully exploited for breeding purposes, have a very positive effect on the general improvement of sheep-breeding in the country.

(c) The outstanding flocks

There were 10 outstanding flocks in Israel in 1955—56, with a breeding standard of over 350 kg of milk. Each of these flocks included several record ewes with over 500 kg of milk.

The gradual development of each flock which kept regular milk records, can be learned from the respective files kept by the Flock Book management. Each file contains all the frequency distributions, summarized on the so-called

Development Sheet, on which the ewes are graded in quality groups at intervals of 50 kg of milk. Absolute numbers as well as the percentage in relation to the total number of ewes in the flock are stated. A scrutiny of these figures and of the changes in the total number of ewes in the flock affords a good picture of the gradual development of the flock and of the way the breeder has chosen for increasing the breeding standard. A decline in the total number of ewes points to the improvement having been achieved by heavy culling in the lower groups. The economic results of a particular year may thus be impaired, because an equal number of work days has to be spent on the flock although it contains less animals. Real improvement, both in the quality of the flock and in its economic performance, is indicated when the breeding standard has been increased together with the increase in the number of ewes as compared to the preceding year. The development sheets of the 11 best flocks in 1955—56 are reproduced in Tables XXXIV and XXXV.

The development file also contains the certificates (vide Figure 28) of all dead as well as of the still active rams used in the flock, with their class mark; this is noted on the development sheet. Thus, past development may be followed and the probabilities for further improvement estimated.

A condensed summary of the development sheets of two outstanding flocks is given in Table XXXII(b) and (c). The Ein Harod flock is the major distributor of breeding stock, particulary rams, to the other flocks in the country. Its influence in the general improvement in sheep-breeding in Israel can hardly be overestimated. Its two senior shepherds, after achieving excellent results in their own flock, consented to work, in turn, as instructors in the Sheep-breeding Section of the Ministry of Agriculture.

It has been found, for instance, that out of 123 examined flocks, 112 used rams bred at Ein Harod. The number of Ein Harod bred rams presently in use in 32 flocks exceeds 50% of all rams in each of these flocks. Progeny tests of rams at Ein Harod have been carried out since 1940. Table XXXII gives an account of the development of the Ein Harod flock as from the end of the 1937—38 milking season. The flock was then in its beginning and had only 72 adult ewes. Within two years, the flock had increased to 227 ewes, partly by purchase of new stock from Arab owned flocks, and partly by rearing sufficient female lambs. Its breeding standard was 175 kg of milk in 1939—40 and it was the best flock in the country. The flock was enlarged and improved its quality from year to year. In 1948—49 it reached a breeding standard of 376 kg of milk for 411 ewes. In the same year, a ewe from Ein Harod achieved the record of 680 kg of milk. The breeding standard decreased since 1949—50, due partly to the elimination of high producing ewes of advanced age and also due to the addition of a great number of young ewes which had not yet reached their full milk producing capacity. The table contains data up to 1950—51, as thereafter the flock was split into two separate units between

TABLE XXXIV

Comparison of the 11 *best flocks in* 1937—38 *and* 1955—56

Normal print — absolute figures; bold— percentages

	Classification No.	Classification No. 1955—56	Flock	Ewes milk recorded	Milk yield in kg Annual	Milk yield in kg Breeding Standard	Milk yield in kg Record	Ewes registered	100	150
1937/38	1	1	Ginegar	116		168.90	290		6	28
									5.17	**24.14**
	2	31	Beit Alfa	155		149.85	285		19	52
									12.26	**33.55**
	3	21	Yagur	81		149.05	290		14	25
									17.28	**30.87**
	4	15	Tel Yosef	78		142.30	245		13	31
									16.67	**39.74**
	5	50	Hefzibah	112		131.30	205		22	51
									19.64	**45.54**
	6	—	Shaar Ha'amakim	55		120.55	190		14	27
									25.45	**49.10**
	7	94	Ein Shemer	98		117.20	220		40	36
									40.82	**36.73**
	8	48	Kadoorie	28		108.90	200		15	11
									53.57	**39.29**
	9	77	Mishmar Ha'emek	120		105.75	215		50	55
									41.67	**45.83**
	10	2	Ein Harod	72		104.40	195		32	33
									44.45	**45.83**
	11	106	Ayelet Hashahar	60		94.50	190		33	23
									55.00	**38.33**
			Total	975		130.95	290		258	372
									26.46	**38.16**
1955/56		1	Ginegar	276	421.89	452.32	730	250		
								90.58		
		2	Ein Harod, Ihud	326	409.32	446.20	890	273	1	1
								83.74	**0.31**	**0.31**
		3	Geva	229	388.06	434.02	810	197		1
								86.02		**0.44**
		4	Ein Harod, Kibbutz Meuhad	215	350.09	393.54	690	159		1
								73.96		**0.46**
		5	Ramat Yohanan	212	349.95	393.02	770	153		
								72.16		
		6	Sarid	174	341.44	391.26	630	125		
								71.85		
		7	Beit Hashitta	248	357.63	375.61	640	163		
								65.73		
		8	Ein Hashofet	283	317.73	369.51	560	174	1	
								61.49	**0.35**	
		9	Gat	229	341.65	364.76	630	144		1
								62.88		**0.44**
		10	Ramat Hashofet	301	319.16	360.23	590	175		
								58.14		
		11	Eshel Hanassi*	100	339.30	339.30	580	42		
								42.00		
			Total	2,593	359.08	397.05	890	1,855	2	4
								66.72	**0.08**	**0.15**

* All ewes two years old.

200	250	300	350	400	450	500	550	600	650	700	750	800	850	900
53	27	2												
45.69	23.28	1.72												
61	21	2												
39.35	13.55	1.29												
29	11	2												
35.80	13.58	2.47												
27	7													
34.61	8.98													
35	4													
31.25	3.57													
14														
25.45														
17	5													
17.35	5.10													
1	1													
3.57	3.57													
14	1													
11.67	0.83													
7														
9 72														
4														
6.67														
262	77	6												
26.87	7.89	0.62												
	1	4	21	40	67	68	39	22	10	3	1			
	0.36	1.45	7.61	14.49	24.28	24.64	14.13	7.97	3.62	1.09	0.36			
3	6	7	35	46	67	60	43	33	15	4	2	2		1
0.92	1.84	2.15	10.74	14.11	20.55	18.40	13.19	10.12	4.60	1.23	0.61	0.61		0.31
1	9	12	9	33	60	47	34	15	5	1	1		1	
0.44	3.93	5.24	3.93	14.41	26.20	20.52	14.84	6.55	2.18	0.44	0.44		0.44	
1	9	17	28	44	58	32	19	4	1	1				
0.46	4.19	7.91	13.02	20.47	26.98	14.89	8.84	1.86	0.46	0.46				
4	5	12	38	52	46	31	12	8	3			1		
1.89	2.36	5.66	17.93	24.53	21.70	14.61	5.66	3.77	1.42			0.47		
1	3	10	35	42	42	23	12	4	2					
0.57	1.72	5.75	20.11	24.14	24.14	13.22	6.90	2.30	1.15					
	7	28	50	69	53	27	9	4	1					
	2.82	11.29	20.16	27.82	21.37	10.89	3.63	1.62	0.40					
5	7	31	65	67	63	31	11	2						
1.77	2.47	10.95	22.97	23.68	22.26	10.95	3.89	0.71						
3	3	17	61	79	41	15	8		1					
1.31	1.31	7.42	26.64	34.50	17.90	6.55	3.49		0.44					
2	13	44	67	73	64	28	8	2						
0.66	4.32	14.62	22.26	24.26	21.26	9.30	2.66	0.66						
4	7	18	29	18	10	6	6	2						
4.00	7.00	18.00	29.00	18.00	10.00	6.00	6.00	2.00						
24	70	200	438	563	571	368	201	96	38	9	4	3	1	1
0.92	2.70	7.71	16.89	21.71	22.02	14.19	7.75	3.73	1.46	0.35	0.15	0.11	0.04	0.04

TABLE XXXV

The 11 best flocks

Normal print—absolute figures; **bold**—percentages

Year	Classification No.	Ewes milk recorded	Milk yield in kg Annual M	Breeding Standard M	Record	Flock Book standard	Ewes registered	100	150	200
Ginegar (est. 1932)										
1935—36		34		166.00	270			1	12	13
								2.94	**35.29**	**38.24**
1936—37		96		149.35	225			6	42	41
								6.25	**43.75**	**42.71**
1937—38		116		168.90	290			6	28	53
								5.17	**24.14**	**45.69**
1938—39	No records									
1939—40		174		164.45	325			19	39	67
								10.92	**22.41**	**38.51**
1940—41	No records									
1941—42		197	132.67	162.59	325			20	45	87
								10.15	**22.85**	**44.16**
1942—43	6	213	155.54	175.68	320	250	16	15	39	77
							7.51	**7.04**	**18.31**	**36.16**
1943—44	8	182	173.40	192.58	360		28	9	21	64
							15.38	**4.94**	**11.54**	**35.17**
1944—45	4	147	205.63	234.66	430		59	2	8	26
							40.41	**1.36**	**5.44**	**17.18**
1945—46	7	140	195.42	242.71	430		60		6	18
							42.86		**4.28**	**12.86**
1946—47	8	95	189.17	244.21	430		47		6	13
							49.47		**6.31**	**13.68**
1947—48	5	133	240.00	258.35	430		76			18
							57.14			**13.53**
1948—49	5	163	270.81	288.28	430	275	54		3	8
							33.13		**1.84**	**4.91**
1949—50	5	181	232.46	279.78	460		93		5	8
							51.38		**2.76**	**4.42**
1950—51	6	209	247.11	286.84	460		121		4	10
							57.89		**1.91**	**4.80**
1951—52	5	228	267.34	296.36	500		149		8	15
							65.35		**3.51**	**6.58**
1952—53	4	274	279.46	315.84	500		201			5
							73.36			**1.82**
1953—54	6	277	279.61	323.00	520		210		3	8
							75.81		**1.08**	**2.89**
1954—55	3	264	414.12	427.35	650		258			
							97.73			
1955—56	1	276	421.89	452.32	730	350	250			
							90.58			
Ein Harod (Ihud) (est. 1936 (1954))										
1937—38		72		104.40	195	250		32	33	7
								44.45	**45.83**	**9.72**
1938—39	No records									
1939—40		227		175.19	290			9	51	96
								3.96	**22.47**	**42.29**
1940—41		241		190.63	310			11	37	87
								4.56	**15.35**	**36.10**
1941—42		267	194.03	206.40	355			12	24	74
								4.49	**8.99**	**27.72**
1942—43	3	284	204.43	218.74	430*	250	105	15	25	54
							36.97	**5.28**	**8.80**	**19.37**

* Israel record yield

Rams: Numbers indicate the Certificate number of the ram. When the ram is no longer in the flock, the number is in brackets

250 300 350 400 450 500 550 600 650 700 750 800 850 900

Rams: AA—(8),13,14. A—(7),15. B—18,20. C—(1),(2),6,9,(10),19. F—(3),4,(5).

6	2									
17.65	5.88									
7										
7.29										
27	2									
23.28	1.72									
42	6	1								
24.14	3.45	0.57								
41	3	1								
20.81	1.52	0.51								
66	15	1								
30.98	7.04	0.47								
60	20	7	1							
32.97	10.99	3.84	0.55							
52	32	19	7	1						
35.61	21.92	13.01	4.80	0.68						
56	28	24	7	1						
40.00	20.00	17.15	5.00	0.71						
29	22	19	5	1						
30.53	23.16	20.00	5.26	1.06						
39	40	25	9	2						
29.33	30.07	18.80	6.77	1.15						
30	58	35	22	7						
18.40	35.59	21.47	13.50	4.29						
34	65	39	22	7	1					
18.78	35.92	21.55	12.15	3.87	0.55					
38	66	53	24	13	1					
18.18	31.58	25.35	11.48	6.22	0.48					
17	68	67	31	18	3	1				
7.46	29.82	29.38	13.60	7.89	1.32	0.49				
30	66	84	57	25	6	1				
10.95	24.09	30.66	20.80	9.12	2.19	0.37				
25	56	80	65	32	6	2				
9.02	20.22	28.88	23.47	11.55	2.17	0.72				
2	6	26	44	89	55	23	13	5	1	
0.76	2.27	9.85	16.67	33.71	20.83	8.71	4.92	1.90	0.38	
1	4	21	40	67	68	39	22	10	3	1
0.36	1.45	7.61	14.49	24.28	24.64	14.13	7.97	3.62	1.09	0.36

Rams: AA—(3),(4), (6),(12),13,(15),(18),(20). A—(9),(11),(21). B—(5),(10). C—(1),(2),(7),(8),16,(17).

54	17			
23.79	7.49			
76	26	4		
31.54	10.79	1.66		
99	48	9	1	
37.08	17.98	3.37	0.37	
85	73	25	5	2
29.58	25.71	8.80	1.76	0.70

TABLE XXXV (continued)
The 11 *best flocks*

Normal print — absolute figures ; bold — percentages

	Classification No.	Ewes milk recorded	Milk yield in kg Annual M	Breeding Standard M	Record	Flock Book standard	Ewes registered	100	150	200
Ein Harod (Ihud) (cont.)										
1943—44	1	296	221 69	239.05	430		162	16	18	42
							54.72	**5.40**	**6.12**	**14.16**
1944—45	3	305	222.45	254.95	480		179	4	17	39
							58.69	**1.31**	**5.75**	**12.89**
1945—46	3	342	228.69	258.07	480		204	11	14	33
							59.65	**3.22**	**4.09**	**9.65**
1946—47	1	355	333.51	334.42	610*		320		1	3
							90.14		**0.28**	**0.85**
1947—48	3	423	298.47	335.70	610		371		6	19
							87.71		**1.42**	**4.49**
1948—49	1	411	314.46	375.74	680*	275	368		2	3
							89.53		**0.48**	**0.73**
1949—50	1	424	289.70	367.74	680		363		3	9
							85.61		**0.71**	**2.12**
1950—51	1	522	277.20	349.60	610		415		7	23
							79.50		**1.34**	**4.41**
1951—52	2	497	259.06	338.32	610		372		6	26
							74.87		**1.21**	**5.23**
1952—53	2	448		323.57	610		318	14	6	18
							70.98	**3.12**	**1.34**	**4.01**
Division of the flock										
1953—54	2	236	345.80	380.55	610		216			2
							91.53			**0.85**
1954—55	1	253	405.90	431.46	770*		240			1
							94.86			**0.40**
1955—56	2	326	409.32	446.20	890*	350	273	1	1	3
							83.74	**0.31**	**0.31**	**0.92**
Geva (est. 1939)										
1941—42		130	210.00	210.65	355				14	40
									10.77	**30.77**
1942—43	2	135	184.35	219.56	355	250	44	4	7	26
							32.66	**2.96**	**5.19**	**19.26**
1943—44	4	170	192.24	217.88	355		50	5	10	38
							29.41	**2.94**	**5.88**	**22.36**
1944—45	1	142	273.52	278.31	470		96		7	12
							67.60		**4.80**	**8.55**
1945—46	1	146	254.10	287.40	440		111		3	7
							76.02		**2.05**	**4.79**
1946—47	2	134	318.81	326.49	520		119			1
							88.81			**0.75**
1947—48	1	127	332.78	346.22	520		118			2
							92.92			**1.57**
1948—49	2	161	314.46	351.80	520	275	142		1	1
							88.20		**0.62**	**0.62**
1949—50	2	178	317.07	363.31	520		167			2
							93.82			**1.12**
1950—51	3	195	261.71	336.46	520		154		1	9
							73.85		**0.51**	**4.62**
1951—52	1	164	326.06	364.63	520		150			
							91.46			
1952—53	1	206	343.85	374.76	560		182			2
							88.35			**0.97**

* Israel record yield

Rams: Numbers indicate the Certificate number of the ram. When the ram is no longer in the flock, the number is in brackets

250	300	350	400	450	500	550	600	650	700	750	800	850	900
58	90	57	12	3									
9.60	30.40	19.24	4.05	1.03									
66	81	73	19	5	1								
1.64	26.46	23.93	6.23	1.64	0.33								
84	90	87	20	6	1								
3.39	26.32	25.44	5.85	1.76	0.28								
31	62	117	73	40	20	4	3	1					
8.73	17.47	32.95	20.57	11.26	5.63	1.13	0.85	0.28					
27	71	112	85	64	28	5	5	1					
6.38	16.79	26.48	20.12	15.13	6.61	1.17	1.17	0.24					
14	51	87	94	75	44	26	13	1	1				
3.41	12.41	21.17	22.87	18.25	10.71	6.33	3.16	0.24	0.24				
28	47	93	85	72	49	22	14	1	1				
6.60	11.09	21.93	20.05	16.98	11.55	5.19	3.30	0.24	0.24				
44	73	108	94	88	53	18	13	1					
8.43	13.98	20.69	18.01	16.86	10.15	3.45	2.49	0.19					
43	80	114	92	71	41	14	9	1					
8.65	16.10	22.94	18.51	14.28	8.25	2.82	1.81	0.20					
47	69	114	79	58	27	9	6	1					
0.49	15.40	25.45	17.63	12.95	6.03	2.01	1.34	0.23					
Rams: AA—4,11,12,13. A—3. B—2,14. C—1.													
7	25	49	59	44	28	11	9	2					
2.97	10.59	20.76	25.00	18.65	11.86	4.66	3.81	0.85					
6	8	30	40	61	48	33	15	7	2		2		
2.37	3.16	11.86	15.81	24.11	18.97	13.04	5.93	2.77	0.79		0.79		
6	7	35	46	67	60	43	33	15	4	2	2		1
1.84	2.15	10.74	14.11	20.25	18.40	13.19	10.12	4.60	1.23	0.61	0.61		0.31
Rams: AA—5,9,12. B—6,10,11,13. C—2,(3),(7). F—(4). G—(1).													
49	20	6	1										
7.69	15.39	4.61	0.77										
54	34	9	1										
9.93	25.26	6.67	0.74										
67	37	12	1										
9.41	21.76	7.07	0.58										
27	39	27	21	8	1								
9.02	27.47	19.02	14.80	5.63	0.71								
25	51	29	24	7									
7.13	34.93	19.86	16.45	4.79									
14	31	36	34	12	4	2							
0.44	23.14	26.86	25.38	8.96	2.98	1.49							
7	22	32	37	15	9	3							
5.51	17.32	25.20	29.14	11.81	7.08	2.37							
8	22	43	44	27	13	2							
4.97	13.66	26.72	27.33	16.77	8.07	1.24							
4	18	45	53	37	16	3							
2.24	10.11	25.28	29.78	20.79	8.99	1.69							
20	24	46	48	32	12	3							
0.26	12.31	23.59	24.61	16.41	6.15	1.54							
9	9	50	42	33	16	5							
5.49	5.49	30.49	25.61	20.12	9.75	3.05							
11	15	44	48	51	23	10	2						
5.34	7.28	21.36	23.30	24.76	11.17	4.85	0.97						

TABLE XXXV (continued)
The 11 best flocks

Normal print — absolute figures; **bold — percentages**

	Classification No.	Ewes milk recorded	Milk yield in kg Annual M	Breeding Standard M	Record	Flock Book standard	Ewes registered	100	150	200
Geva (cont.)										
1953—54	1	204	401.16	418.77	610		194			1
							95.10			**0.49**
1954—55	2	208	369.30	428.37	640		198			1
							95.19			**0.48**
1955—56	3	229	388.06	434.02	810	350	197		1	1
							86.02		**0.44**	**0.44**
Ein Harod (Kibbutz Meuhad) (est. 1954)										
1953—54	8	208	215.05	311.30	580	275	139		5	17
							66.82		**2.40**	**8.18**
1954—55	5	203	340.77	375.91	580		186			2
							91.62			**0.98**
1955—56	4	215	350.09	393.54	690	350	159		1	1
							73.96		**0.46**	**0.46**
Ramat Yohanan (est. 1940)										
1943—44	23	113	166.95	166.95	400	250	7	14	26	37
							6.19	**12.39**	**23.01**	**32.75**
1944—45	9	118	211.98	216.10	470		34	5	11	28
							28.81	**4.24**	**9.32**	**23.67**
1945—46	No records									
1946—47	16	113	200.91	230.09	470		45		19	19
							39.82		**16.81**	**16.81**
1947—48	7	138	234.35	249.93	510		70	5	7	27
							50.72	**3.62**	**5.07**	**19.57**
1948—49	7	169	244.26	265.33	510	275	70	5	8	22
							41.42	**2.96**	**4.73**	**13.02**
1949—50	9	179	240.34	266.48	540		87	8	14	16
							48.60	**4.47**	**7.82**	**8.94**
1950—51	19	232	225.09	255.82	540		98	15	15	26
							42.24	**6.46**	**6.46**	**11.21**
1951—52	7	190	268.14	290.73	540		109	2	5	17
							57.36	**1.05**	**2.64**	**8.95**
1952—53	7	226	271.81	303.23	540		124		3	17
							54.87		**1.33**	**7.52**
1953—54	19	220	197.29	284.18	540		133		17	21
							60.45		**7.73**	**9.54**
1954—55	6	223	341.21	364.93	700		196		4	4
							87.89		**1.79**	**1.79**
1955—56	5	212	349.95	393.02	770	350	153			4
							72.16			**1.89**
Sarid (est. 1937)										
1942—43	8	185	153.96	172.59	310	250	13	5	52	70
							7.03	**2.70**	**28.11**	**37.84**
1943—44	16	177	143.35	178.12	340		16	8	38	68
							9.04	**4.52**	**21.47**	**38.42**
1944—45	12	174	190.35	207.82	380		39	6	17	40
							22.41	**3.45**	**9.77**	**22.99**
1945—46	15	161	194.76	218.32	420		42	3	12	44
							26.09	**1.87**	**7.45**	**27.33**
1946—47	10	151	185.23	239.07	420		61		11	17
							40.40		**7.28**	**11.26**

* Israel record yield

Rams: Numbers indicate the Certificate number of the ram. When the ram is no longer in the flock, the number is in brackets

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
6	5	21	39	59	37	27	7	2						
2.94	2.45	10.29	19.12	28.92	18.14	13.24	3.43	0.98						
4	9	15	37	59	35	32	11	5						
1.92	4.33	7.21	17.79	28.37	16.83	15.38	5.29	2.40						
9	12	9	33	60	47	34	15	5	1	1		1		
3.93	5.24	3.93	14.41	26.20	20.52	14.84	6.55	2.18	0.44	0.44		0.44		

Rams : AA—15,23. A—21. C—8,17.

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
31	32	57	30	19	10	5	2							
14.90	15.39	27.40	14.42	9.14	4.81	2.40	0.96							
7	19	44	51	43	23	11	3							
3.45	9.36	21.68	25.12	21.18	11.33	5.42	1.48							
9	17	28	44	58	32	19	4	1	1					
4.19	7.91	13.02	20.47	26.98	14.89	8.84	1.86	0.46	0.46					

Rams : AA—13. A—8,14. B—(9),(10),11,15,17,18,19. C—(3). D—(2),(4),(5),6. F—(1),(7).

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
29	4	2		1										
25.66	3.54	1.77		0.88										
40	18	10	3	2	1									
33.96	15.25	8.48	2.54	1.69	0.85									
30	24	10	8	2	1									
26.55	21.24	8.85	7.08	1.77	0.89									
29	33	18	13	2	3	1								
21.02	23.91	13.04	9.42	1.45	2.17	0.73								
33	44	25	19	8	4	1								
19.53	26.04	14.79	11.24	4.73	2.36	0.60								
30	41	35	23	7	2	3								
16.76	22.90	19.55	12.85	3.91	1.12	1.68								
47	48	45	23	9	3	1								
20.26	20.69	19.40	9.91	3.88	1.29	0.43								
35	41	38	32	13	5	2								
18.42	21.58	20.00	16.84	6.84	2.63	1.05								
35	47	61	39	16	7	1								
15.49	20.80	26.99	17.26	7.07	3.10	0.44								
28	47	52	38	13	2	2								
12.73	21.36	23.64	17.27	5.91	0.91	0.91								
12	21	49	59	34	20	12	7			1				
5.38	9.42	21.97	26.46	15.25	8.97	5.38	3.14			0.45				
5	12	38	52	46	31	12	8	3			1			
2.36	5.66	17.93	24.53	21.70	14.61	5.66	3.77	1.42			0.47			

Rams : AA—6,9. A—4,(5),(8). C—3. E—11. F—(1),(2).

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
45	11	2												
24.32	5.95	1.08												
47	13	3												
26.55	7.35	1.69												
72	29	7	3											
41.38	16.66	4.03	1.72											
60	21	13	6	2										
37.26	13.05	8.07	3.73	1.24										
62	33	18	8	2										
41.06	21.86	11.92	5.30	1.32										

TABLE XXXV (continued)
The 11 best flocks

Normal print—absolute figures ; bold—percentages

	Classification No.	Ewes milk recorded	Milk yield in kg Annual M	Breeding Standard M	Record	Flock Book standard	Ewes registered	100	150	200
Sarid (cont.)										
1947—48	10	181	215.73	240.88	430		85	6	9	32
							46.96	**3.32**	**4.97**	**17.68**
1948—49	8	194	229.59	262.78	460	275	76		5	26
							39.17		**2.58**	**13.40**
1949—50	12	193	193.87	259.58	460		73		8	21
							37.82		**4.14**	**10.88**
1950—51	7	192	241.75	284.58	460		93		2	10
							48.44		**1.04**	**5.21**
1951—52	8	223	249.78	288.97	490		119		2	10
							53.36		**0.90**	**4.48**
1952—53	3	214	274.36	317.01	520		149		2	3
							69.63		**0.93**	**1.40**
1953—54	4	198	287.41	329.55	530		161			5
							81.31			**2.52**
1954—55	4	173	356.45	388.82	630		166			
							95.95			
1955—56	6	174	341.44	391.26	630	350	125			1
							71.85			**0.57**
Beit Hashita (est. 1933)										
1942—43	10	162	161.79	163.39	360	250	12	16	46	59
							7.40	**9.88**	**28.39**	**36.43**
1943—44	12	185	171.49	187.94	370		34	16	29	57
							18.37	**8.65**	**15.67**	**30.82**
1944—45	14	185	185.77	203.46	370		49	9	18	57
							26.49	**4.86**	**9.73**	**30.82**
1945—46	9	191	209.29	230.94	390		80		23	37
							41.88		**12.05**	**19.37**
1946—47	17	142	186.73	228.94	390		60	5	14	28
							42.25	**3.52**	**9.86**	**19.72**
1947—52	No records									
1952—53	29	234	253.63	253.63	450	275	90		5	44
							38.46		**2.14**	**18.80**
1953—54	12	202	285.79	301.24	520		137			11
							67.82			**5.45**
1954—55	12	225	318.55	331.82	520		185			7
							82.22			**3.11**
1955—56	7	248	357.63	375.61	640	350	163			
							65.73			
Ein Hashofet (est. 1937)										
1945—46	34	149	159.80	173.35	340	250	14	14	30	55
							9.40	**9.40**	**20.14**	**36.91**
1946—47	30	133	179.93	195.86	340		21	4	17	48
							15.79	**3.01**	**12.78**	**36.09**
1947—48	33	208	170.70	189.09	400		27	26	34	61
							12.98	**12.50**	**16.35**	**29.32**
1948—49	39	252	181.34	199.21	410	275	44	23	41	64
							17.46	**9.13**	**16.27**	**25.40**
1949—50	41	272	168.00	209.93	410		48	19	36	57
							17.65	**6.98**	**13.24**	**20.96**
1950—51	23	257	217.02	244.16	480		89	7	14	45
							34.63	**2.72**	**5.45**	**17.51**

* Israel record yield

ms: Numbers indicate the Certificate number of the ram. When the ram is no longer in the flock, the number is in brackets.

250	300	350	400	450	500	550	600	650	700	750	800	850	900
49	49	22	10	4									
07	27.07	12.16	5.52	2.21									
56	50	29	19	8	1								
88	25.76	14.95	9.79	4.12	0.52								
61	46	31	18	7	1								
61	23.83	16.06	9.33	3.63	0.52								
49	52	41	25	12	1								
52	27.09	21.35	13.02	6.25	0.52								
17	68	56	25	12	3								
08	30.49	25.11	11.21	5.38	1.35								
23	53	67	39	20	6	1							
75	24.77	31.31	18.22	9.35	2.80	0.47							
17	34	64	45	24	6	3							
59	17.17	32.32	22.73	12.12	3.03	1.52							
3	13	36	41	47	18	10	4	1					
73	7.52	20.81	23.70	27.17	10.40	5.78	2.31	0.58					
3	10	35	42	42	23	12	4	2					
72	5.75	20.11	24.14	24.14	13.22	6.90	2.30	1.15					

Rams: AA—12. A—(10). B—19. C—(2),(11),(14),15,(16),17. E—(7). F—(4),(5),(6),(8),(9). G—(3)

250	300	350	400	450	500	550	600	650	700	750	800	850	900
29	9	2	1										
90	5.55	1.23	0.62										
19	27	5	2										
19	14.59	2.70	1.08										
52	38	8	3										
11	20.45	4.32	1.62										
51	50	30	10										
70	20.94	15.71	5.23										
35	34	16	10										
55	23.94	11.27	7.04										
58	68	41	15	2	1								
79	29.06	17.52	6.41	0.86	0.42								
22	61	65	32	7	3	1							
39	30.20	32.18	15.84	3.47	1.48	0.49							
15	28	90	50	27	6	2							
57	12.44	40.00	22.22	12.00	2.67	0.89							
7	28	50	69	53	27	9	4	1					
32	11.29	20.16	27.82	21.37	10.89	3.63	1.62	0.40					

Rams: AA—5,22. A—(4),9,10,11,(12). C—(1),6,7. E—(2). F—(3)

250	300	350	400	450	500	550	600	650	700	750	800	850	900
36	12	2											
16	8.05	1.34											
13	19	2											
13	14.29	1.50											
50	20	6		1									
35	9.62	2.88		0.48									
56	48	14	5	1									
12	19.05	5.55	1.98	0.40									
12	57	16	4	1									
14	20.96	5.88	1.47	0.37									
56	65	41	13	4	2								
58	25.29	15.95	5.06	1.56	0.78								

TABLE XXXV (continued)

The 11 best flocks

Normal print—absolute figures; bold—percentages

	Classification No.	Ewes milk recorded	Milk yield in kg Annual M	Breeding Standard M	Record	Flock Book standard	Ewes registered	100	150	200
Ein Hashofet (cont.)										
1951—52	6	270	274.08	291.18	560		153	7	2	29
							56.67	**2.59**	**0.74**	**10.74**
1952—53	6	285	251.04	305.05	560		189		8	19
							66.32		**2.81**	**6.67**
1953—54	5	293	306.48	329.11	580		212		4	10
							72.35		**1.37**	**3.41**
1954—55	8	278	316.42	353.81	580		235		3	2
							84.53		**1.08**	**0.72**
1955—56	8	283	317.73	369.51	560	350	174	1		5
							61.49	**0.35**		**1.77**
Gat (est. 1943)										
1948—49	41	118	154.53	189.32	290	275	3	8	17	34
							2.54	**6.78**	**14.41**	**28.81**
1949—50	35	269	210.44	215.39	420		40	4	23	79
							14.87	**1.49**	**8.55**	**29.37**
1950—51	36	267	209.00	230.82	390		52		10	54
							19.48		**3.75**	**20.22**
1951—52	27	226	190.85	245.53	420		54	2	2	8
							23.89	**0.88**	**0.88**	**3.54**
1952—53	33	276	213.95	244.24	400		81	7	13	24
							29.35	**2.54**	**4.71**	**8.69**
1953—54	16	254	276.51	292.80	520		172		6	9
							67.72		**2.36**	**3.54**
1954—55	10	244	298.00	332.74	630		226			1
							92.62			**0.41**
1955—56	9	229	341.65	364.76	630	350	144		1	3
							62.88		**0.44**	**1.31**
Ramat Hashofet (est. 1941)										
1948—49	23	169	226.67	230.06	440	275	45	9	7	37
							27.48	**5.33**	**4.14**	**21.89**
1949—50	26	193	192.70	224.45	440		44	8	12	45
							22.80	**4.14**	**6.22**	**23.32**
1950—51	11	203	230.25	264.63	490		90	6	5	18
							44.33	**2.96**	**2.46**	**8.87**
1951—52	4	232	264.62	298.19	590		141		10	11
							60.77		**4.31**	**4.74**
1952—53	10	258	250.96	294.77	590		151	5	10	15
							58.52	**1.94**	**3.87**	**5.81**
1953—54	3	263	314.40	335.06	590		206		2	11
							78.33		**0.76**	**4.18**
1954—55	7	271	322.11	356.31	590		239			2
							88.19			**0.74**
1955—56	10	301	319.16	360.23	590	350	175			2
							58.14			**0.66**
Eshel Hanassi (est. 1954)										
1954—55		94	135.32		260			28	36	23
								29.79	**38.30**	**24.47**
1955—56	11	100	339.30	339.30	580	350	42			4
							42.00			**4.00**

* Israel record yield

ns: Numbers indicate the Certificate number of the ram. When the ram is no longer in the flock, the number is in brackets.

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
7	77	52	33	16	12	3	2							
0	28.53	19.26	12.22	5.93	4.44	1.11	0.74							
5	72	73	36	21	17	2	2							
8	25.26	25.61	12.63	7.37	5.97	0.70	0.70							
9	51	73	53	31	23	5	4							
1	17.40	24.92	18.09	10.58	7.85	1.70	1.37							
4	43	75	63	41	26	6	5							
3	15.47	26.98	22.66	14.75	9.35	2.16	1.80							
7	31	65	67	63	31	11	2							
7	10.95	22.97	23.68	22.26	10.95	3.89	0.71							

Rams: AA—4. A—9,10,11. B—3. C—6. D—7. E—2. G—(1),(5),(8).

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
1	18													
5	15.25													
1	54	12	5	1										
3	20.07	4.46	1.86	0.37										
8	71	20	4											
4	26.59	7.50	1.50											
4	74	21	4	1										
5	32.74	9.30	1.77	0.44										
4	92	37	8	1										
6	33.33	13.41	2.90	0.36										
7	81	93	29	7	1	1								
3	31.89	36.62	11.42	2.76	0.39	0.39								
5	65	92	48	22	7	3		1						
5	26.64	37.70	19.67	9.02	2.87	1.23		0.41						
3	17	61	79	41	15	8		1						
1	7.42	26.64	34.50	17.90	6.55	3.49		0.44						

Rams: AA—7,12. A—6,(8),10. B—(13). C—(1). E—(2). G—(3),(4).

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
52	37	19	7	1										
78	21.89	11.24	4.14	0.59										
57	47	15	7	2										
53	24.35	7.77	3.63	1.04										
52	53	44	12	8	5									
52	26.11	21.67	5.91	3.94	2.46									
36	62	57	31	16	6	2	1							
52	26.72	24.57	13.36	6.90	2.59	0.86	0.43							
17	54	54	43	20	7	2	1							
21	20.93	20.93	16.67	7.75	2.73	0.77	0.39							
18	41	78	60	31	16	5	1							
35	15.59	29.66	22.81	11.79	6.08	1.90	0.38							
15	35	69	70	51	19	8	2							
53	12.92	25.46	25.83	18.82	7.01	2.95	0.74							
13	44	67	73	64	28	8	2							
32	14.62	22.26	24.26	21.26	9.30	2.66	0.66							

	250	300	350	400	450	500	550	600	650	700	750	800	850	900
6	1							All ewes yearlings						
38	1.06							All ewes two years old						
7	18	29	18	10	6	6	2							
00	18.00	29.00	18.00	10.00	6.00	6.00	2.00							

the members of the settlement. Since then each part has its own file and development sheet in the Flock Book.

Geva has at present the third best flock in the country, with the high breeding standard of 434 kg of milk from 229 ewes. Records of the development in this flock exist as from the 1941—42 milking season, when its breeding standard was 211 kg averaged from 130 adult ewes. As can be seen from Table XXXII, the flock is small, having approximately half the number of ewes in the Ein Harod flock. The flock shows a steady increase in its breeding standard, with the exception of 1950—51, when a large number of old ewes was culled and replaced by young ones. The flock soon recovered and by 1955—56 it had 164 ewes (72% of the total) yielding over 400 kg of milk. The young ewes added to the flock during the last few years proved to be heavy milkers.

The improvement of the Awassi in Israel, as shown by the above examples, is illustrated graphically in Figure 29.

40. *Daily maximum yield*

In an investigation of a flock of Cyprus fat tailed sheep carried out by the author in 1938 [4], the correlation coefficient between the milk yield and the daily maximum yield was $+0.7464 \pm 0.0253$, as calculated from data on 30 ewes. This high coefficient indicates that this factor can be taken into consideration, for selection purposes, in addition to the annual milk yield, or in cases where the annual milk yield is unavailable. This factor has been included, therefore, in the point system for the evaluation of ewes. The corresponding correlation coefficient found in the Awassi in Israel is $r = +8102$ ** with 222 D.F. (vide Table XLI).

All the recorded lactations of 989 ewes, belonging to Ein Harod, Geva, Kfar Giladi Table XXXVI lists the groups at intervals and Ginegar, were investigated. The calculated mean was 2.67 kg ± 0.0157, with a standard deviation of $\sigma = \pm\ 0.492$ kg. of 0.5 kg of milk. The observed minimum was 1.5 kg, whilst the maximum was 4.5 kg. It follows that only 4.25% of the ewes had a daily maximum yield of less than 2.0 kg of milk. In 68.35% it was 2.0—3.0 kg, in 24.98% 3.0—4.0 kg, while in 24 ewes (2.42%) the daily maximum exceeded 4.0 kg. In the 1955—56 milking

TABLE XXXVI

Daily maximum milk yield

Maximum milk yield reached per day	Ewes in each group	
kg	No.	%
1.5—1.9	42	4.25
2.0—2.4	300	30.33
2.5—2.9	375	38.02
3.0—3.4	203	20.53
3.5—3.9	44	4.45
4.0—4.4	22	2.22
4.5	2	0.20
Total	989	100.00

Mean $= 2.67$ kg ± 0.0157
S.D. $= \pm 0.492$ kg

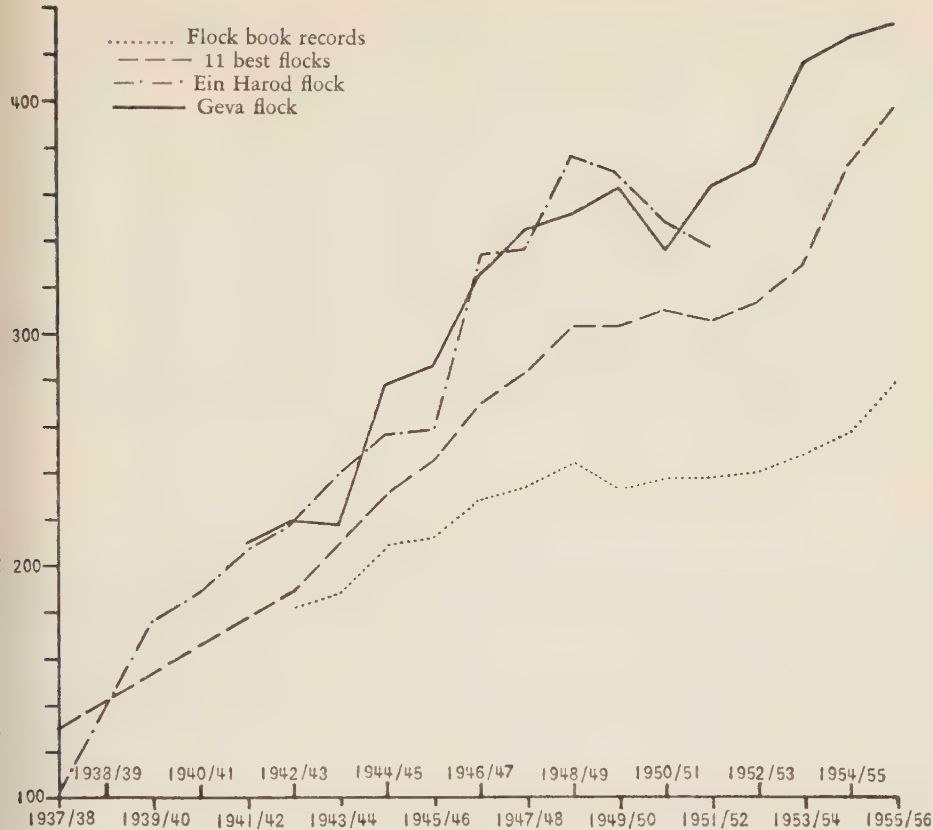


Figure 29

Improvement of the Awassi breed sheep in Israel

season, which is not included in this investigation, daily maximum yields of up to 6.0 kg have been recorded.

41. Length of lactation

The correlation coefficient between milk yield and length of lactation was found to be +0.6558 ± 0.0324, as calculated from 307 ewes of Cyprus fat tailed sheep[8]. The corresponding figure for Awassi in Israel is +0.4849 ** with 222 D.F. (vide Table XLI). To find the mean length of the lactation period, the records of 235 ewes with at least 7 and some with 8 or 9 lactations, were examined. Late lactations, starting after 15.II, were excluded, as they are seldom completed. A total of 1,718 lactations was obtained, representing all age groups up to the 9th lactation, at the end of which the ewe is almost 11 years old. The results are shown in Table XXXVII, with intervals of 25 days between groups. The mean is 200.80 days ± .6628. The shortest

lactation period was 112 days, the longest 295 days. The standard deviation is $\sigma = \pm$ 27.470 days. 62.22% of the lactations lasted 178—227 days, whilst 18.39% were shorter and 19.39% longer.

Most flocks dry off the ewes yielding less than 200 g of milk per day. However, some shepherds continue to milk such ewes, as the fat content of the milk is very high at the end of the lactation. Eventually, when the value of the product obtained becomes less than the expenses involved, milking of the whole flock is stopped.

TABLE XXXVII
Length of lactation

Length of lactation	Lactations in each group	
Days	No.	%
112—127	7	0.41
128—152	87	5.06
153—177	222	12.92
178—202	581	33.82
203—227	488	28.40
228—252	308	17.93
253—277	23	1.34
278—295	2	0.12
Total	1,718	100.00

Mean = 200.80 days ± 0.6628
S.D. = ± 27.470 days

42. *Life performance*

In order to find the average milk production during the life time of th Improved Awassi, the registered ewes from 11 flocks were investigated. Ew with at least six completed lactations were chosen at random, and they all had reached the age of two years when the first lactation started, so that they were 7—11 years old at the time of the investigation. The number of ewes in the higher age groups was naturally smaller, as only good producers are kept in the flock up to this age. Table XXXVIII contains the results, showin the number of ewes in each age group, the mean life performance and the averag annual milk yield. This last figure is seen to diminish with advancing age, whic is in accordance with the influence of age on milk production (see below).

TABLE XXXVIII
Life time performance of ewes from 11 flocks

Age	Lactations	Ewes in each group	Life time milk yield M	S.E.	S.D.	Avera milk yield per yea
Years			kg	kg	kg	kg
7	6	213	1,623	26.28	383.57	271
8	7	225	1,732	22.96	344.42	247
9	8	174	1,961	30.86	407.07	245
10	9	90	2,184	41.70	395.62	243
11	10	37	2,227	65.83	400.44	223

Table XXXIX gives the highest life time performance achieved by eigh ewes, one from each age group: ranging from a 5-year old ewe to one o 12 years of age, although there exist only very few of the latter. In additio to the average annual milk yield, maximum yield per year and per day ar also shown.

Almost all of these record yielders are or were from Ein Harod, but mo of them are now dead. The exceptional performance of ewe No.7513 shoul be noted, as she holds the record for milk production. Her maximum is 888.5 k

per year and 5.5 per day. Her life time production until now has reached 3,157 kg, giving an average of 526 kg per year for six consecutive lactations.

TABLE XXXIX
Maximum life performance yield

Ewe register No.	Flock	Lactations	Life total kg	Milk yield Average per year kg	Maximum per year kg	Maximum per day kg
7774	Geva	4	2,245	561	810	4.9
2231	Ein Harod	5	2,246	449	591	3.8
7513	Ein Harod	6	3,157	526	888	5.5
2987	Geva	7	2,957	422	544	3.4
2	Ein Harod	8	3,283	410	481	3.1
104	Ein Harod	9	3,459	384	564	3.5
356	Ein Harod	10	3,085	308	472	3.2
14	Ein Harod	11	3,140	285	450	2.7

Note: 1st lactation starts when the ewe is two years old.

She delivered as a yearling, despite late lambing (9.III.1951), 296 kg of milk. Fat production during her sixth lactation amounted to 55.011 kg (6.2%). Her translated Flock Book Card is reproduced in Figure 27, and her picture in Figure 13. Her daughter, No. 193-C, whose picture is shown in Figure 14, produced in 1955—56 350 kg of milk as a yearling, although she, too, lambed late, but has all prospects to attain records.

43. *Influence of age on milk production*

This problem, important in fixing correction factors for age, was investigated as follows:

The flocks of Ein Harod and Geva were chosen because of their geographical proximity; there were no great differences in the general environmental conditions and their influence on milk production during the various years under observation. Ewes with 7—9 consecutive lactations were selected, representing all age groups up to 10 years. Lactations which started after 15.II were excluded from the calculation. A total of 1,718 lactations was obtained, with over 200 lactations in each age group up to the 7th lactation, while for the 8th and 9th lactations the available numbers were 124 and 61, respectively.

The investigation was based on the following three factors, which are available from the recording system of the Flock Book Cards: (a) the annual milk yield, (b) the daily maximum yield, (c) the length of lactation. In order to afford a comparison of these three items with each other, each was expressed as a percentage of the first lactation. The results are contained in Table XL and Figure 30.

TABLE XL

Influence of age on milk production

Average from 235 ewes with at least seven lactations

			Annual milk yield						Daily maximum yield				Length of lactation			
Age	Lactation	Number of lactations in each age group	M.	S.E.	S.D.	In relation to first lactation	In % of total milk yield	Age correction factor for fourth lactation's milk yield	M.	S.E.	S.D.	In relation to first lactation	M.	S.E.	S.D.	In relation to first lactation
Years	No.		kg	kg	kg	%	%		kg	kg	kg	%	days	days	days	%
2	1	207	223.77	4.9552	71.290	100.00	8.74	1.47	1.691	0.0329	0.475	100.00	182.37	1.6556	23.820	100.00
3	2	223	275.56	5.7685	86.141	123.14	10.77	1.19	2.029	0.0360	0.537	119.99	191.28	1.6568	24.742	104.89
4	3	218	307.71	5.7160	84.397	137.51	12.03	1.07	2.167	0.0340	0.502	128.15	199.59	1.6305	24.074	109.44
5	4	224	328.08	5.3129	79.518	146.61	12.82	1.00	2.262	0.0316	0.473	133.77	206.38	1.6625	24.882	113.16
6	5	210	317.00	5.7261	82.977	141.65	12.39	1.03	2.138	0.0340	0.493	126.43	209.74	1.6927	24.530	115.01
7	6	220	309.14	5.2697	78.161	138.15	12.08	1.06	2.098	0.0325	0.481	124.07	208.25	1.7925	26.586	114.19
8	7	231	281.56	5.6385	85.699	125.80	11.00	1.16	1.907	0.0339	0.516	113.96	204.18	2.0258	30.789	111.96
9	8	124	260.00	6.6852	74.440	116.19	10.16	1.26	1.818	0.0459	0.512	107.51	203.75	2.6705	29.738	111.72
10	9	61	256.23	9.2928	72.577	114.51	10.01	1.28	1.702	0.0593	0.463	100.65	205.66	4.2149	32.919	112.77
		1,718	2,559.05				100.00									

(a) The annual milk yields are expressed as percentages of the first lactation and of the total milk yield from 9 lactations. Assuming the yield of the

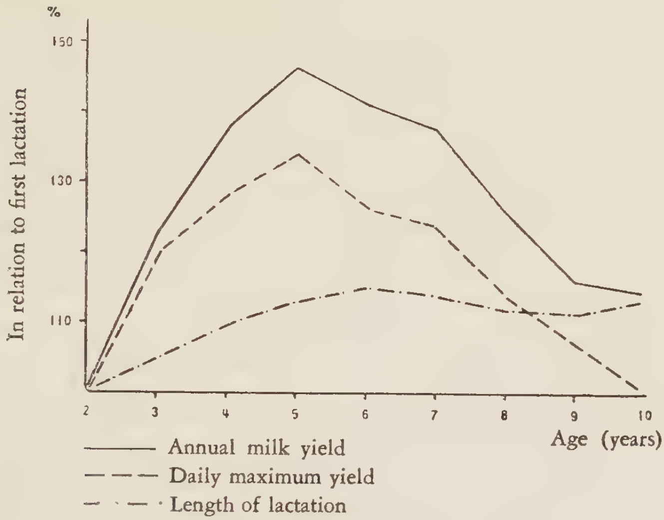


Figure 30
Influence of age on milk production

first lactation at 100%, the 2nd lactation equals 123.14%, with increasing yields up to the fourth lactation, when it reaches 146.61%; at this time the ewe is five years of age. Starting with the 5th lactation, production declines; this is sharpest in the 7th and 8th lactation, and the yield of the 9th lactation equals 114.51%. An even greater decrease was to be expected in the higher age groups, but its absence can be explained by the small amount of records available for these age groups and by the fact that only very good ewes are retained up to this age. There were actually several ewes yielding 400—500 kg of milk in their 8th lactation and one ewe from Geva produced 510 kg in her 9th lactation.

Assuming the total yield from 9 lactations to constitute the life time yield, we see that from the 3rd to the 6th lactations, the ewe yields annually about 12% of the life time yield. From the 7th lactation, production declines in a way similar to that in which it rose at the beginning of its milking life. The practice of keeping a ewe in the flock up to her 8th year of age, is therefore well founded, provided there were no reasons for earlier culling. So, too, is the habit of retaining in the flock exceptionally good ewes as long as possible; this is done primarily in order to obtain as many lambs as possible for breeding purposes. These ewes usually well repay the cost of keeping them in their old age. Figure 31 gives the life time curve based on these figures.

The correction factor for age has been obtained by dividing the yield of the 4th lactation by the yields of each of the three preceding years. The factors

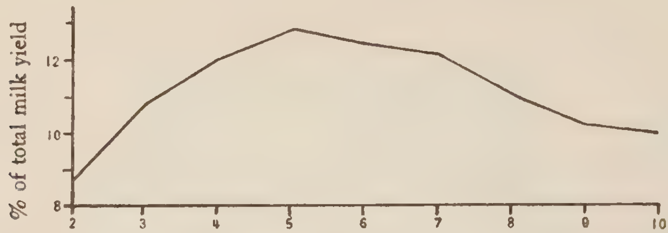


Figure 31
Life performance curve

are 1.47 for the 1st, 1.19 for the 2nd and 1.07 for the 3rd lactation, and they afford an estimate of the maximum milk yield to be expected from a ewe in good health and under normal environmental conditions. The age correction factor for subsequent lactations may be useful whenever an older ewe is added to the flock and no information about her previous performance is available.

(b) The importance of the daily maximum yield in estimating the breeding value of a ewe has been dealt with above. The influence of age on the daily maximum yield was investigated in order to find which of the two main factors responsible for milk production is more affected by age: the daily maximum yield or the length of lactation. A comparison of the annual milk yield with each of these factors provides some information on the magnitude of their significance, as long as they are expressed as a percentage of the respective first lactation figure (vide Table XL). The daily maximum yield closely follows the trend of the annual milk yield (vide Table XL and Figure 30). The maximum daily yield reaches its peak, 2.262 kg, in the 4th lactation period. From then on it steadily declines, and in the 9th lactation almost equals that of the first: 1.702 kg and 1.691 kg, respectively. The decline continues at the same rate even in the 8th and 9th lactations, indicating that the relatively high annual milk yields reached by ewes in this age group were primarily due to greater length of lactation rather than to a higher daily maximum yield.

(c) The length of lactation follows the same trend during the first four lactations, by increasing similarly to, but to a smaller degree than, the daily maximum yield; this indicates the smaller effect of this factor on the annual milk yield. It reaches its maximum in the 5th lactation and not in the 4th, with an average of 209.74 days (115.01% of the 1st lactation). The ensuing decline is slight and the curve again rises during the 8th and 9th lactations. This confirms the previous remark that the relatively high annual milk yields in the last two age groups were achieved primarily by longer lactation periods.

A correlation between the annual milk yield and the daily maximum yield as well as the length of lactation is given in Table XLI. The calculation was based on the 4th lactation, and all ewes were of the same age and at their maximum milk producing capacity. The correlation coefficient between the annual milk yield and the daily maximum yield reached the high value of +0.8102, whereas the correlation coefficient between the annual milk yield and the length of lactation, though highly significant, has, nevertheless, the lower value of +0.4849. The results confirm, therefore, the observations made in the discussion of the influence of age on these two factors, namely that the daily maximum yield is more important in estimating the milk production capacity of a ewe, than the length of lactation. From this follows that the intensity of milk production is more significant than a prolonged lactation for achieving high milk yields. The correlation between the daily maximum yield and the length of lactation had a very small coefficient of +0.0841, indicating that there is no connection between these two factors in the milk production of the Awassi ewe. A previous investigation made by the author, on the Cyprus fat tailed sheep [8], gave a fairly high correlation coefficient of +0.3069 between these items, suggesting that ewes with a higher daily milk production often also had a longer lactation period. This assumption was not confirmed in the Awassi, whose milk production is generally much higher than that of the Cyprus sheep.

TABLE XLI

Correlation
annual milk yield — length of lactation
and
daily maximum yield — length of lactation

Correlation	r	D.F.
4th lactation yield — daily maximum yield	+0.8102**	222
4th lactation yield — length of lactation	+0.4849**	222
Daily maximum yield — length of lactation	+0.0814	222

** The correlation coefficient is significant at the 1% level

44. *The repeatability of milk yields*

The material employed in finding the influence of age on milk production was also used in this investigation. The milk yield of the 1st lactation was correlated with the milk yields of each of the following lactations (vide Table XLII for results), and the coefficients were all positive.

The correlations between the 1st and 2nd, and between the 1st and 3rd lactations were of the same order, +0.5558 and +0.5585, respectively. With the increasing years intervening between the 1st and the later lactations, the correlation coefficient decreases. It remains significant, however, at the 1%

level up to the 7th lactation, despite the interval of five years; this means that a ewe with high production in her first lactations retains this capacity up

TABLE XLII
Repeatability of milk yields

Correlation	r	D.F.
1st lactation yield — 2nd lactation yield	+0.5558**	195
1st lactation yield — 3rd lactation yield	+0.5585**	189
1st lactation yield — 4th lactation yield	+0.3607**	195
1st lactation yield — 5th lactation yield	+0.4244**	184
1st lactation yield — 6th lactation yield	+0.2389**	193
1st lactation yield — 7th lactation yield	+0.2148**	202
1st lactation yield — 8th lactation yield	+0.1595	104
1st lactation yield — 9th lactation yield	+0.1198	51
Maximum milk yield — 1st lactation yield	+0.5236**	205
Maximum milk yield — 4th lactation yield	+0.7435**	222

** The correlation coefficient is significant at the 1% level.

to her 7th lactation, when she reached about 9 years of age, by which time most ewes are usually culled. The correlation coefficients between the 1st and the last two lactations, the 8th and the 9th, though positive, were, however, not significant. The numbers for these two groups were also much smaller.

The maximum milk yield achieved by a ewe during her life time forms the basis of the breeding standard yield and of all selection work in the Awassi; the correlation coefficient with the 1st lactation is as high as +0.5236 with 205 D.F.

This result clearly indicates that for selection purposes, the ewe's milk producing potential may be estimated from the 1st lactation yield. Hitherto ewes were usually kept for two or three lactations before decisions on culling were made. Anyhow, they had to be culled in most cases and the expenses incurred in feeding and keeping them for two more years were unnecessary. The flock as a whole is likely to benefit, even when a few valuable ewes are culled prematurely.

The breeder is thus given a means of ascertaining whether a young ewe is likely to reach the breeding standard of his flock. All he has to do is to multiply the ewe's 1st lactation yield by the age correction factor (1.47) in order to arrive at the probable milk yield of the 4th lactation. In case the result falls far below the breeding standard of the flock, the young ewe should be culled and sold to a new flock about to be established, where the breeding standard is still low. If, on the contrary, the result surpasses the breeding standard of the flock, the breeder can rear all ewe lambs for retention. This does not, however, apply to the rearing of ram lambs, as there are enough proven high producing ewes available, so that no risks need to be taken in this direction.

The maximum milk yield is not always attained in the 4th lactation, as besides age, other important factors, such as year-to-year differences, may greatly influence milk production. The correlation coefficient between maximum milk yield and the 4th lactation yield was found to be as high as +0.7435 with 222 D.F., proving that the milk yield of the 4th lactation can in most cases be taken as an indicator of the maximum yield.

Similar results in the investigation of the repeatability of milk yields were obtained by Mason and Dassat [12] in the Italian Langhe and Sopravissana breeds. The average correlation coefficient in successive lactations in the Langhe sheep was +0.69 and in the Sopravissana +0.68. In alternate lactations it was +0.64 and in lactations separated by two years +0.45, for the Langhe sheep.

45. *Milk yield and body development*

The body development of a ewe, as expressed by height at withers and live weight, was correlated to milk production. In order to reduce the influence of the age factor, both the maximum milk yield and the 4th lactation yield were used. The results are contained in Table XLIII.

The correlation coefficient between height and maximum milk yield is +0.1604, which is significant only at the 5% level, whereas that with the 4th lactation yield is +0.2352, being significant at the 1% level. This shows that taller ewes usually produce more milk.

TABLE XLIII
Correlation
milk yield — body development

Correlation	r	D.F.
Height at withers — Maximum milk yield	+0.1604*	233
Height at withers — 4th lactation yield	+0.2352**	222
Body weight — Maximum milk yield	+0.2033**	233
Body weight — 4th lactation yield	+0.0925	222

* The correlation coefficient is significant at the 5% level.
** The correlation coefficient is significant at the 1% level.

A similar investigation of Cyprus fat tailed sheep, carried out by the author, resulted in the only slightly significant correlation coefficient of +0.1571 ± 0.0557, between height at withers and milk production [4].

In another investigation made by the author, on oxen of the Illyrian breed in Bosnia, a clear correlation was found between body conformation and working capacity [5].

The correlation between body weight and maximum milk yield is +0.2033, which is low but as yet significant at the 1% level, whilst the 4th lactation yield is reduced to the insignificant value of +0.0925. The body weight of a ewe is subject to considerable changes during the seasons of the year, and depends on the prevailing feeding conditions and on the intensity of milk production, both of which strongly influence body weight. The correlation is based on weights taken in November and December. However, the weighings were carried out in different years, depending on the registration date of the ewes.

This fact may account for the low correlation coefficients obtained for body weight and milk production.

It may perhaps be concluded that a taller and heavier ewe usually produces more milk, although the respective correlation coefficients are low.

It is not suggested, therefore, that special emphasis should be put on body development when greater milk production is the principal aim of selection. In this case, the correlation between body development and milk production should be used in such a way that by selecting better milk producers, the average body development of the breed, particularly height and weight, will eventually be improved. This is a slow process, which shows, however, results and which can be traced by comparing the body development of ewes from flocks with high milk production with ewes from flocks with a lower milk production standard.

The method usually employed in the selection of ram lambs should be continued ; namely, the special consideration of the body development of the dam and that of the ram lamb itself.

46. *Butter fat content*

The butter fat content of the milk is recorded only for ewes which have produced at least 370 kg of milk and have been selected for the rearing of ram lambs. In the 1953—54 season, an official recorder regularly tested the butter fat content of a total of 498 ewes from 11 flocks.

The results, showing the frequencies of the different groups, are contained in Table XLIV. The minimum recorded fat content is 5.8%, the maximum 8.8%, resulting in a fairly wide range of 3.0% for individual ewes. This clearly indicates that there are good prospects for improvement in this direction. Butter fat testing of milk should, therefore, be extended to a larger number of ewes, with the ultimate aim of testing all ewes registered in the Flock Book. The rentability of a flock could be increased and the additional expenses involved could be covered.

TABLE XLIV

Butterfat content in milk of Awassi sheep

Average butterfat content %	Ewes in each group No.	Ewes in each group %
5.8—5.9	1	0.20
6.0—6.4	36	7.23
6.5 6.9	153	30.72
7.0—7.4	218	43.78
7.5—7.9	74	14.86
8.0—8.4	14	2.81
8.5—8.8	2	0.40
Total	498	100.00

Mean = 7.06% ± 0.0200
S.D. = ± 0.446%

Most of the sheep milk is used in cheese manufacture; "Tnuva", the principal marketing organization, pays according to the fat content of the milk.

Maymone and Carusi[13] have found a high correlation (+0.656 ± 0.0183) between the lipoids and the proteids in sheep milk. Selection for increased fat content would, therefore, result in higher cheese production yields. Less milk would then be needed to manufacture a given quantity of cheese.

In 1953—54 the fat content of the 498 controlled ewes averaged 7.06%. This figure is rather constant, as the mean from 612 ewes recorded in 1950—51 was 6.98%.

No significant divergencies in fat content were found in milk from different flocks (vide Table XLV). The fat content of all other flocks varied between the values shown in the Table; this means that in none of the flocks has selection with a view of increasing fat content been carried out.

TABLE XLV

Butterfat content averages in different flocks

Flock	Recorded ewes	Butterfat content %	S.D.
Sde Nahum	20	6.72±0.0632	±0.2805
Sarid	46	7.37±0.0535	±0.3639

TABLE XLVI

Butterfat production of individual ewes in 1955—56

Ewe	Flock	Milk production kg	Butterfat production kg	%
596	Ein Harod	888.5	55.011	6.2
802	Ein Harod	758.0	47.270	6.2

The quantity of fat produced by some outstanding ewes in the course of a single lactation is fairly high, as can be seen from Table XLVI. Ewe No.596 produced in a single lactation period a quantity of butter fat which amounts to 85% of her body weight of 65 kg. This ratio compares favourably, to the best of the author's knowledge, with that of a cow whose butter fat production during one lactation represents a smaller percentage of her body weight. This proves that sheep are very good butter fat producers; since they obtain the greatest part of their food from natural pasture, they appear to be the most economic producers of butter fat.

The fat content fluctuates rather strongly even in the course of a single lactation period. The mean difference between minimum and maximum of each of the 498 examined ewes was found at 2.44% ± 0.0453, with a S.D. of $\sigma = \pm$ 1.0103%. The minimum recorded fat content was 5.0%, whilst the maximum was 12.0%.

Kern[11], in his extensive investigation of sheep milk, calculated average fat contents from milk received at the "Tnuva" dairy in Tel Aviv during a period of three years (vide Table XLVII). The results give a good illustration of the aforesaid.

TABLE XLVII

Average butterfat content of sheep milk

Month	XII	I	II	III	IV	V	VI	VII	VIII	IX
Butterfat content %	6.70	7.30	6.90	6.80	6.70	8.20	8.40	8.70	9.11	10.00

The difference between minimum and maximum fat content recorded during a single lactation for an individual ewe may be as high as 6%. This was the case with ewe No.671 from Geva, which had a minimum of 6.0% at the beginning and a maximum of 12.0% at the end of one and the same lactation period. Her daily milk production ranged from 2.8 kg to 0.2 kg at the end of this period. Her average fat production during this lactation period was, however, 6.8%.

VIII. MEAT PRODUCTION

Whilst the income from milk accounts for about 60% of the total gross income of a flock, meat production occupies second place. Income from meat production consists mainly of the sale of lambs for slaughter, and, to a lesser extent, of the sale of culled sheep considered unsuitable for breeding. However, the part occupied by meat production in the economics of the flock largely depends on market prices for meat, which showed some improvement during the past year or two.

47. *Lambs for meat production*

Experiments carried out several consecutive years both at the Government Stock Farm, Acre [1] and in several settlements have been aimed at finding ways and means of reducing the cost of feeding lambs earmarked for slaughter.

Partial suckling resulted in a considerable reduction of the most expensive item, milk; consequently, most breeders have decided to retain male lambs for at least two months before weaning and, in some cases, up to the age of four months.

Average figures on the development of two groups of male lambs kept under different feeding conditions, are given in Table XLVIII. These two experiments were carried out at the Government Stock Farm, Acre, in 1950—51 and 1951—52. The weighings were made once weekly, on the same day and at the same time of the day.

TABLE XLVIII

Weight increase in male lambs

Experiments at the Government Stock Farm, Acre

	1950—51 *		1951—52	
	Group A 18 male lambs Intensive feeding		Group B 13 male lambs Extensive feeding	
Age	Live weight at end of interval	Average daily weight increase during interval	Live weight at end of interval	Average daily weight increase during interval
Weeks	kg	gr	kg	gr
Birth	4.690		5.350	
4	13.770	324	13.880	305
8	22.380	307	22.560	310
12	29.440	252	24.180	58
16	35.200	206	30.790	236
20			35.960	185
22			37.790	131

* Adapted from Table II in Atzmon and Doron, *Report on experiments in the sheep branch at the Akko Farm* (1951).

Both groups were kept, up to the time of weaning at the age of 60 days, under feeding conditions similar to those in general use. Partial suckling was applied as from the beginning of the 4th week. In addition, the lambs were

given 200 gr of concentrates daily and as much green fodder and hay as they would eat.

After weaning, they were fed in the following ways:

Group A was kept indoors (in pens) and the daily ration of concentrates was augmented to 400 gr during the 3rd month and to 600 gr during the 4th month. Moreover, the lambs consumed during the third month a daily average of 2.400 kg of green clover and 500 gr of hay. These quantities were raised during the 4th month to 4.500 kg of green clover and 400 gr of hay.

Group B was on good quality pasture for about eight hours per day. The lambs were not given any additional food in the pen.

As was to be expected, the development of both groups showed no differences up to weaning. Their daily gain in weight was more than 300 gr and by the end of the 4th week they weighed about 14 kg and at the end of the 8th week about 22 kg.

In the four weeks after weaning, the daily increase in live weight of Group A dropped to about 250 gr, so that they weighed about 29 kg by the end of the 12th week. Thereafter, this downward trend became even more accentuated, when the daily live weight increase fell to 200 gr; the live weight at the end of the 16th week was 35 kg, despite the increased ration of concentrates and green fodder.

Group B lost weight in the first two weeks after weaning, but recovered slightly towards the end of the first 4-week period, so that they showed a slight daily increase in live weight of about 60 gr; they weighed about 24 kg at the end of the 12th week. In comparison with Group A, these lambs weighed about 5 kg less at this age. Although development was satisfactory during the following 4-week period, in which the daily increase in live weight was higher than that in Group A, the lambs attained an average live weight of 35 kg only at the end of the 20th week; in other words, they required four weeks more than Group A in order to reach the same weight. By the end of the 22nd week, these lambs had an average live weight of 38 kg.

When comparing these two methods of fattening lambs for meat production and remembering the other experiments made in this direction, the economic aspect of this problem has to be examined. The slaughter weight and the quality of the meat produced must also be considered.

48. *Improvement of body weight and height in adult ewes*

In the outstanding flocks, attention is paid to the improvement of body conformation and to uniformity in the outward appearance of the animals. The following method has been adopted in order to express this in figures.

Once a year, all ewes to be registered in the Flock Book are inspected by a commission recording their body measurements and weights. Four of the

outstanding flocks (Ein Harod, Geva, Sarid and Ginegar) have been chosen for a comparison of their weights and measurements, obtained in June 1953 and June 1954, with the breed averages. Body weight and height at withers were taken as indicators of the general development of the animal. The ewes from each flock were examined separately in order to find any differences between the flocks.

The breed average (vide Tables VI and VIII) is based on 2,039 measurements and 1,211 weighings of ewes from all flocks included in the Flock Book. Ewes registered from 1942 to 1946 were taken at random.

The results of this comparison (wide Table XLIX) may be summarized briefly as follows.

TABLE XLIX

Improvement of body weight and height in ewes from some outstanding flocks

Flock	Body weight				Height at withers			
	Ewes	M kg	S.E. kg	S.D. kg	Ewes	M kg	S.E. kg	S.D. kg
Breed average	1,211	50.30	0.2075	7.2220	2,039	69.26	0.0681	3.0771
Ein Harod	72	63.10	0.8422	7.1466	72	73.46	0.3491	2.9619
Geva	58	59.09	0.7421	5 6515	58	70.64	0.3386	2.5791
Sarid	42	63.52	1.2848	8.3265	42	71.02	0.4068	2.6362
Ginegar	45	59.47	0.7578	5.0835	45	71.69	0.3418	2.2931
4 flocks average	217	61.35	0.4688	6.9062	217	71.87	0.1970	2.9025

Body weight (average of 217 animals) increased by 11 kg. There existed differences between the individual flocks, and ewes registered in the last two years from Ein Harod and Sarid averaged 63 kg as compared to 59 kg for ewes from Geva and Ginegar.

The highest body weight, 85 kg, was that of ewe No.772 from Sarid; she measured 72 cm height at withers and had a maximum milk yield of 359 kg in her 3rd lactation.

Taking the breed average of 50 kg as a basis, it is found that some flocks increased the average body weight by about 18% and in few cases even by as much as 26%.

Height at withers shows only slight deviations, about 4%, in the 217 measurements. The increase was greatest in the Ein Harod flock, whose ewes were some 6% higher than the average of the Awassi.

The maximum height at withers, 80 cm, was reached by three ewes from Ein Harod.

Height of body alone does not, however, express the real body development. Measurements, such as breadth and depth of chest and length of body must also be considered, as breeders generally prefer ewes with a well proportioned body conformation over those merely excelling in body height.

IX. WOOL PRODUCTION

The wool of the Awassi is coarse, mixed with hair and suitable chiefly for the manufacture of carpets. The wool crop of the past two years has been exported to England and was readily bought on the international market. However, income from wool is only a minor item in the economics of a sheep flock in Israel.

Whilst the yearly production of a good milking ewe may easily be worth IL. 100, the amount realized from the sale of its wool would only be about IL. 3. This difference is chiefly responsible for the almost total neglect of wool production, and no steps have so far been taken to improve either quantity or quality of wool. This is reflected in the points system for the evaluation of ewes in Israel, in which out of 100 points, 50 are reserved to milk production and only 5 to wool production.

The situation has hardly changed since 1933 when Hirsch[7] wrote: "The average fleece of a Palestinian ewe is (on the basis of many weighings undertaken by us) 1.75 kg; that of a yearling sheep is 1.40 kg, that of a ram is 2.25 kg and that of a lamb is 0.50 kg."

Most breeders do not even go to the trouble to weigh the shorn wool, although this recording would be necessary only once a year. There are known to exist large differences in wool yield of individual ewes from the same flock.

An additional reason for this neglect is the aversion of the principal breeders to the introduction of wool improvement into their breeding policy, as they do not want to deviate from the more important aims of milk production and body conformation. They argue that the inclusion of an additional factor in their selection work might only complicate matters and could distract them from their principal aim. If this reasoning had some weight at the beginning of the selection work, it is no longer so. There are now sufficient good milking ewes meeting the requirements for breeding ram lambs to be selected partly on the basis of wool production. Such rams should preferably be given to the more advanced flocks with established milk production qualities.

The Sarid flock has actually been working on these lines for several years and has a much higher average fleece weight than any other flock in the country. At the same time it is amongst the best flocks in milk production, with a breeding standard of 391 kg of milk. Sarid recorded fleece weights since 1938, and this shows that the breeders there have always paid attention to this aspect. In order to find the achievements in this direction, Table L was compiled on the basis of the average for the years 1948, 1949, 1950 and 1952, no records being available for 1951. The averages are calculated from all ewes, without consideration of their age, but which were good milkers and registered in the Flock Book.

434 weighings resulted in a mean fleece weight of 2.966 kg, which is 70% above the breed average of 1.750 kg.

TABLE L
Wool production improvement in the Sarid flock

Fleece weight kg	Fleece weights in each group No.	%
1.1—1.4	4	0.92
1.5—1.9	39	8.99
2.0—2.4	83	19.12
2.5—2.9	102	23 50
3.0—3.4	93	21.43
3.5—3.9	52	11.98
4.0—4.4	41	9.45
4.5—4.9	11	2.54
5.0—5.4	4	0.92
5.5—5.9	3	0.69
6.0—6.4	1	0.23
6.5	1	0.23
Total	434	100.00

Mean = 2.966 kg ± 0.0411
S.D = $\pm$ 0.8555 kg

76% of all fleeces weighed 2.0—3.9 kg, whilst 14% exceeded 4.0 kg. The maximum was reached by ewe No.704, which in 1950 produced 6.5 kg of wool. Ewes with both high milk and wool production were often recorded, such as ewe No.705 (491 kg of milk and 4.850 kg of wool) and ewe No.67 (365 kg of milk and 5.500 kg of wool). These examples clearly show that wool production may be improved without impairing milk production.

Correlations between fleece weight and body development are contained in Table LI. The maximum fleece weight was correlated with the body development of the ewe, as represented by height and weight. A positive correlation exists between body weight and fleece weight. The resulting coefficient of +0.3232 is significant at the 1% level. It indicates that the heavier ewes, which are in good bodily condition, generally produce more wool.

TABLE LI
Correlation between fleece weight and body development

Correlation between		r	D.F.
Maximum fleece weight —	body weight	+0.3232**	129
Maximum fleece weight —	height at withers	+0.0254	133
Maximum fleece weight —	number of points for body conformation	+0.2811**	132
Maximum fleece weight —	maximum milk yield	+0.1420*	197

* The correlation coefficient is significant at the 5% level.
** The correlation coefficient is significant at the 1% level.

No correlation was, however, found between height and fleece weight. The correlation coefficient, as low as +0.0254, indicates that body weight is more important than height with regard to wool production. This fact is easily explained by the occasional occurrence of high legged animals with otherwise poor measurements, so that their height influences neither body weight nor fleece weight.

In order to reduce the influence of such cases, the maximum fleece weight was correlated with the number of points the ewe had obtained for body conformation. As the points are awarded on the basis of all body measurements, their sum represents, therefore, a numerical expression of the body development as a whole. The correlation coefficient obtained was $+0.2811$, indicating a slight but significant correlation at the 1% level.

The maximum fleece weight was also correlated with the maximum milk yield of the ewe. The coefficient obtained was $+0.1428$, which is on the border line of significance at the 5% level, with 197 D.F.

Mason and Dassat [13] obtained for the Langhe breed a positive correlation coefficient of $+0.28$ with 389 D.F. From further investigation in this direction they concluded that "the positive phenotypic correlation is entirely due to the temporary environmental effect."

While there appears to be no connection between milk production and wool yield of the ewe, it is, however, clear that these two characteristics do not conflict with each other and that improvement in wool production of the Awassi ewe may be undertaken without impairing the principal aim — the continued improvement of milk production.

X. SUMMARY

The Awassi breed of sheep has been described and its response to the improvement of environment conditions.

The Improved Awassi of Israel has been described and data are given on body measurements and weights, as recorded from ewes and rams registered in the Flock Book. The environmental conditions are also described.

Four flocks, situated in different parts of the country, with a total of 1,789 registration cards, formed the basis for these investigations. Where necessary, additional flocks have been included, and the corresponding cards, out of a total of 10,000, have been used.

Data on sex ratio, barrenness, abortion and mortality of lambs are given.

The distribution of lambing in adult ewes is examined and late lambings, those occurring after 15.II, have been found to amount to 8.42% of the total. In order to reduce the ratio of late lambings, which are undesirable under the conditions of sheep husbandry in this country, lambing dates during the life time of ewes are scrutinized.

From the records of 500 ewes with 5—10 consecutive lambings, it has been found that about 60% lambed during a relatively short period. These are designated as ewes with "all lambings concentrated". In about 30%, one or more occasionally two lambings occur distinctly outside the concentrated period; these ewes are described as ewes with "almost all lambings concentrated"; this is caused in about 47% of these cases by age. Two-year old ewes, lambing for

the first time, tend to lamb late in the season. Older ewes, those over eight years, also tend to lamb late. The cause for late lambing could not be traced in the remaining ewes, but it is thought to be the ewe's poor condition in that year. 90% of the concentrated lambings are covered by a span of 42 days. In the remaining 10%, lambings during the life time of the ewes are "wide spread and irregular". These ewes are mainly responsible for late lambings in the flock. Such cases should be eliminated from the flock after three or four consecutive lambings, in order to restrict the number of late lambings. Such a procedure is, naturally, recommended only to flocks with sufficient active rams and with a properly working controlled service.

Twinning is found to occur in 9.28% of 4,549 births. The distribution of twin births differs from that of single births. Twinning occurs mainly at the beginning of the lambing season; prior to 15.XII, 42% of all twin births, but only 27% of the single births occur. Regional differences account for both the ratio and the distribution of twinning. Regions where grain is extensively grown and more stubble grazing is available, generally show a higher ratio of twinning. The influence of grain fed before and during the early stages of the mating is decisive on the increase of twinning and on the early concentration of lambing in general. There is an indication that genetical factors influence the recurrence of twinning. The influence of age on twinning is also discussed. In the Awassi, the highest incidence of twinning is with 6-year old ewes. A gradual increase up to this age and a decrease thereafter is noted.

A tendency to improve precocity in the Awassi is noted. The most frequent age for precocious lambing is about 15 months. Ewes born after 16.II do not incline to precocious lambing; out of 389 observations, only one such case is known.

The method of recording and calculating milk yields and of the evaluation of individual ewes is described.

The course of lactation, at intervals of 30 days, is given as the ratio of the total milk yield. The Awassi ewe produces about 20% of the total milk yield during the first month of the lactation period. This ratio remains fairly constant during the two following months, so that up to the end of the first 90 days about 57% of the total milk yield is produced. Production decreases during the ensuing months and stops in the 7th month, during which only 6% of the total yield are produced.

The improvement of milk production is described, giving data on its gradual development over a period of 18 years, from 1937—38, when the first country-wide records were collected, to the end of the 1955—56 season. The life performance of the Improved Awassi ewe is also given.

The influence of age on milk production is examined. The maximum is achieved in the 4th lactation which starts when the ewe is five years old. Taking the first lactation at 100%, the production of the 4th lactation is 146.61%.

Production decreases from the 5th lactation and falls to 114.51% in the 9th lactation.

The life performance curve, expressed as a function of the life time milk yield of the ewe, is given.

The correction factor for age, in relation to the yield of the 4th lactation, is 1.47 for the 1st, 1.19 for the 2nd and 1.07 for the third lactation.

The influence of age on the daily maximum yield of milk and on the length of lactation is also investigated. Intensity of milk production is more important than its duration. This is confirmed by correlating these two values with the annual milk yield. The correlation coefficient for the daily maximum yield is +0.8102, whereas lactation length and milk yield have a coefficient of +0.4849. No correlation exists between the last two items, and their coefficient is as low as +0.0841.

The repeatability of milk yields is examined by correlating the 1st lactation's yield with each of the subsequent lactations. All correlation coefficients thus obtained are positive. They start with +0.5558 for the 2nd lactation and decline steadily to +0.2148 for the 7th lactation.

The correlation coefficient between the 1st lactation's yield and the maximum yield ever produced by a ewe is highly significant (+0.5236), as is also that between the 4th lactation's yield and the maximum yield (+0.7435).

These results allow the conclusion that selection can be based on the yield of the 1st lactation, provided conditions at the time are normal.

The correlation between body development (height and weight) and milk production indicates that bigger and heavier ewes usually produce more milk than smaller animals.

The fat content of the milk has a fairly constant average of about 7.0%, with a range of about 3% between the recorded maximum and minimum. Ewes with a butter fat production of nearly 85% of their body weight, during one lactation, are recorded.

The potential of the Awassi for meat production is discussed and an experiment is described, in which the live weight increase of lambs with intensive and extensive feeding is compared. The improvement already obtained in the body development of adult ewes in some of the best flocks indicates that still further improvement in this direction is possible.

Wool production is studied, with particular reference to one flock, Sarid, where an increase of about 70% in fleece weight has been achieved, as compared with the average wool production of other flocks. Sarid has an average of 3.0 kg of wool, with a maximum of 6.5 kg.

Although a positive correlation (+0.3232) exists between body weight and fleece weight of a ewe, no correlation has been obtained between height at withers and fleece weight.

The correlation between milk production and wool production is +0.1428, which is on the border of significance at the 5% level.

The work done in the Sarid flock, one of the best in Israel, demonstrates that fleece weight is not incompatible with selection for high milk production.

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STUDIES ON VECTORS OF SCHISTOSOMA IN ISRAEL

G. WITENBERG AND Z. SALITERNIK

CONTENTS

STUDIES ON VECTORS OF SCHISTOSOMA IN ISRAEL *

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ABSTRACT

This study was undertaken because of the urgent need to evaluate the possibilities of the spread of schistosomiasis in Israel, as a result of the influx of numerous infected immigrants from endemic foci.

The information on schistosomiasis and its local vectors in the past is summarized. Two snail-vectors, *Bulinus truncatus* and *Biomphalaria alexandrina* have been known to occur in a few foci. Factors facilitating the spread of these vectors in the past are discussed. Statistics of the recent influx of infected persons are quoted; about 12,000 of them, mostly immigrants from Yemen, are shedding ova, mainly of *Schistosoma mansoni*. Local *Bulinus* also serves as a vector of two trematodes injurious to livestock, *S. bovis* and *Paramphistoma* sp.

Characteristics of watercourses and basins are given and it is shown that schistosome vectors need a loamy bed and water with a current below 20 cm/sec. Breeding places of both Bulinus and Biomphalaria are associated with plants of which *Potamogeton nodosum* is the most important. The life span of both snails is about $1\frac{1}{2}$ years. Stress is laid mainly on the bionomics and ecology of Bulinus. Fluctuations in snail population are described and their causes discussed. Predators feeding on snails are mentioned, but their role in controlling the snail population is negligible.

Artificial structures connected with water utilization play a significant role in supporting the snail population. The main breeding foci are described and a list of sites, where Bulinus was recently found, is compiled.

In laboratory experiments, the local strain of Bulinus proved to be refractory to the strain of *S. haematobium* from Yemen and Morocco, while it showed 4% take with the Iraq strain and about 30% take with the Egyptian strain. The infection by the latter strain is, however, irregular, and often kills most of the infected snails.

The discrepancies between the presence of schistosome carriers and vectors, on the one hand, and the rarity of new schistosome infections, on the other hand, is explained.

The present situation of schistosomiasis in Israel may be summarized as follows: Intestinal schistosomiasis presents only clinical problems, but has no prospect of spreading; regarding urinary sihistosomiasis, the situation is different, as epidemiological factors for its spread exist and precautionary measures are to be taken; nevertheless, the situation can be defined as bulinismus without schistosomiasis.

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I. INTRODUCTION

1. *Purpose of the study*

The influx, during the last five years, of thousands of immigrants carrying schistosome infection has caused a serious concern with respect to public health in Israel. The danger of spread of this infection was based on the following considerations:

(a) snail vectors of two Middle East species of the human schistosomes, *Schistosoma haematobium* and *S. mansoni,* are present in the country ;
(b) autochthonous schistosomiasis has previously been proved in Israel ;
(c) changes in hydrological conditions — planned and partly implemented — as for instance creation of water reservoirs, introduction of a wide and complicated irrigation system, numerous fish ponds, etc., are liable to increase suitable conditions for the breeding of snail vectors ;
(d) the immigrant carriers of the parasites belong largely to an uneducated class with little consciousness of hygiene.

The present study was undertaken to elucidate the factors favouring the spread of schistosomiasis in this country and their reciprocal or combined influence on its seemingly growing threat. The following problems were chosen for investigation:

(a) distribution of Bulinus and Biomphalaria snails in Israel ;
(b) ecological conditions influencing their breeding and distribution ;
(c) influence of man's activity on the spread of schistosome vectors;
(d) epidemiological interdependence between the presence of snails and spread of schistosomiasis under local conditions.

2. *Nomenclature of the snail vectors*

There is no accord among malacologists on the nomenclature of the vectors of schistosomes. In this study we shall tentatively accept two names: *Bulinus truncatus* * for the vector of *S. haematobium and Biomphalaria alexandrina* ** for the vector of *S. mansoni,* in the Mediterranean region. We assume that *Biomphalaria* is represented in this country by a single race, while *Bulinus* occurs either as a short and truncated variety or as an elogated one, and both may be smooth or ribbed. Although each of these forms usually occurs in a certain locality, all intermediate forms may sometimes be found in the same habitat. Whether these forms constitute distinct species, as proposed by Haas (1935), or represent modifications due to ecological factors, remains to be solved by

* Hass (1935) showed that this name has no taxonomic status; we nevertheless retain it here owing to its wide use.

** The authors are grateful to Dr. J. Bequaert for personal communications clarifying the taxonomy of this species.

further study including the breeding of all forms in the laboratory on a sufficiently large scale.

3. *Schistosomiasis and its vectors in Israel up to 1948* *

(a) *Occurrence of snail vectors*

Snails involved in transmission of schistosomiasis in man have probably existed in the territory of Israel from time immemorial. They are known to occur in neighbouring countries: in Egypt, where schistosomiasis has been known since pharaonic times, and in Lebanon, where Bulinus was found 150 years ago. Their occurrence in this country was recorded much later; all previous records relate only to the coastal part of Israel.

The first record of Bulinus in Israel territory was made by Kobelt (1896), as quoted by Haas (1935), who established *Isidora rollei* for specimens collected in the vicinity of Jaffa. Preston (1913) found in Lake Kinneret at the entrance of the Jordan River an empty shell which he determined as *Physa tiberiadensis*. Searle (1918) reported *Isidora contorta* in irrigation cisterns in the vicinity of Petah Tikva (some of the snails were infected with schistosome cercariae, and *S. haematobium* was diagnosed in labourers who bathed in these cisterns). Buxton and Krikorian (1922) recorded the presence of Bulinus in Wadi Musrara, in the Rubin River, and in two irrigation cisterns, one of which was fed by water pumped from the Yarkon River. All these points were located within a radius of 10 km from Tel Aviv. In Wadi Musrara the snails were found only during November-December. Ayoub (1922) found that 9% of Bulinus snails recovered from Rubin River were infected with *Schistosoma*. The Government Health Report of 1929 recorded Bulinus snails in an irrigation cistern in Um-Khalid which was fed from a deep well and was located far from any river or swamp. A high incidence of *S. haematobium* among the local population was known at that time. In the same year, Prof. M. Aschner ** found some Bulinus snails in the swamps Birkat-Batikh and Birkat-Ata, near Hadera. The Government Health Report of 1931 indicated the presence of Bulinus snails in Wadi Mowilla. Witenberg (1938) published the first record of *Biomphalaria alexandrina (Planorbis boissyi)* in Wadi Musrara (near Tel Aviv) in October 1935.

(b) *Data on local cases of schistosomiasis*

Little is known about presence of schistosomiasis in Israel prior to World War I. It is presumed that the disease existed here, but it was not recognized or not recorded. A suggestion that schistosomiasis was present in the country

* This date, the establishment of the State of Israel, was chosen, as from then on the sweeping hydrographic and demographic changes radically affected conditions in the following years.

** of the Hebrew University of Jerusalem; personal communication.

was made by Masterman as early as 1908. Auerbach (1913) published the first records of local schistosomiasis. Buxton and Krikorian (1922) mentioned that authentic cases acquired in a cistern in Petah Tikva and the Rubin River had been found before 1914. In 1918 Dr. G. Stuart (as quoted by Felix, 1925) determined ova of *S. haematobium* in the urine of 3 children from Tel Aviv who had bathed in one of the cisterns used for bathing by Egyptian labourers. In 1921 Felix found 23 out of 53 schoolchildren of the Jewish orphanage in Jaffa and 13.3% of the 158 pupils of the Mikve Israel Agricultural School infected with *S. haematobium.* In a survey made by the Government medical authorities in the same year, 355 cases were established among children in the Jaffa district, which constituted about 10% of the total examined (Government Health Report, 1921). These investigations also established local cases in Um-Khalid (at present a suburb of Nathanya). In 1922 Malchi (as quoted by Felix, l.c.) found 13 cases among the immigrants settled in the Borokhov quarter of Tel Aviv. In the same year, Buxton and Krikorian established an endemic focus in the vicinity of Jaffa, where 6.6% of 470 children were found to be infected. The following localities have been found endemic: Sheikh Munis (15% of school boys), Salameh, Rishon le-Zion, Kfar Uria, Beit Jis, Petah Tikva and the surroundings of the Rubin River.

Fairley and Fairley (1929) established in Australia four cases of infection with *S. haematobium* among Jewish immigrants from Palestine, two of them showing in addition ova of *S. mansoni* in the urine. Scott, Ayoub and Reitler (1934) reported another 3 cases of *S. mansoni* infection in the Arab villages of Jarisha and Jamassin-Gharbiya near Tel Aviv. Younowitz (1938) established 6 cases of local *S. mansoni* infection in children born in Tel Aviv, who had bathed in the Yarkon River. Witenberg (1938) recorded the frequency of *S. haematobium* infection among the inhabitants of the above mentioned villages and noted that about 30% of the cases also showed ova of *S. mansoni* in the urine *. It should be pointed out that such a high frequency of involvement of the urinary tract by *S. mansoni* has not been recorded in any other locality in the world **. These cases were probably caused by a peculiar local strain of *S. mansoni* limited to this particular focus.

During the period 1918—1948 (Palestine Mandate) routine examinations of human excreta, carried out in Government and private clinical laboratories,

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* Unfortunately, the prevalence of intestinal involvement by this parasite in the villages was not investigated. The villages do not exist any more, and the cases are not available for reexamination.

** Barlow and Abdel Azim (1946) indicate 3% of the population of Tanan village (Egypt) showing ova of *S. mansoni* in urine, as contrasted with 59% in stools. Stress is laid on the severity of the infection.

established every year numerous cases of *S. haematobium* and isolated cases of *S. mansoni* infection. They were mostly revealed during sporadic outbreaks of schistosomiasis in various localities in the coastal plain, sometimes involving several hundred cases. Two examples of such outbreaks:

(i) In 1928 the late Dr. R. Younovitz * established 170 cases of urinary schistosomiasis among Jewish youths who had bathed in the Yarkon River, with 9 of them showing both *S. haematobium* and *S. mansoni* ova. Among 19,092 examinations of urine carried out in the Government laboratories during that year, ova of *S. haematobium* were registered in 251 cases, and of 15,770 examinations of faeces, 8 showed the presence of *S. mansoni*. It is not clear, however, whether these data include immigrants from Yemen who had brought the infection from their country of origin.

(ii) In 1929, 81 new cases of *S. haematobium* infection were registered, among them 30 Beduins who acquired the infection by bathing in an irrigation cistern near Hadera.

In the same year, the Government health statistics showed 135 cases of *S. haematobium* from among 23,072 routine examinations of urine and 4 cases of *S. mansoni* from among 13,609 examinations of faeces carried out in various Government laboratories. Although most cases referred to in this chapter deal with locally acquired infection, a few may have been immigrants from Yemen, Iraq or Egypt.

All localities in which schistosome vectors were found in the past and in which schistosomiasis cases have been recorded are situated in the coastal parts of the country.

(c) Some factors favouring the spread of schistosomiasis in the past

Maintenance of foci of schistosomiasis is due to a complex of factors among which the presence of vectors and dispersal of the eggs of the parasite by man is essential. Some human activities in the past have played a significant supplemental role in the maintenance of local schistosomiasis.

Several ways of introduction of parasites into Israel have been known:

(i) Visits by Coptic pilgrims from Egypt, hundreds of whom used to come to this country every year, mostly at Easter, and stay for several weeks.

(ii) Transit through Israel of caravans plying between oriental countries. Their personnel, mainly Beduins, often carried schistosome infection acquired in Egypt or elsewhere.

(iii) Armies, mainly Turkish soldiers, who in the past were intermittently stationed in Egypt, Iraq and Palestine, and the Egyptian Labour Corps of the British Army during World War I.

(iv) Egyptian labourers, extensively employed in orange groves.

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* of the Hadassah Hospital, Tel Aviv; personal communication.

The maintenance of schistosomiasis foci in Israel prior to 1948 was due mainly to the prevalence of infection among the rural Arab population, which was mostly poor, uneducated and lived under very primitive conditions, using infested water for bathing, laundry and drinking. Several efforts by the Government or public agencies to treat them did not show appreciable results, as it was impossible to induce the patients to submit to prolonged treatment with its long trips to the hospital.

Prior to 1948, Moslems used to gather for the midsummer festival of Nabi Rubin near Rubin River (point 80 on the map). Multitudes camped and bathed in the river which was infested with Bulinus. Infected carriers transmitted the infection to the snails and thus spread the disease. According to the Government Health Report of 1937, urine examinations of 3,442 Arabs assembled for a Nabi Rubin festival revealed 393 (11.4%) cases of infection with *S. haematobium* and 9 cases with *S. mansoni*. The infections were presumably acquired in the Rubin, Sukreir and Yarkon Rivers.

4. *Recent status of schistosomiasis in Israel*

Since the establishment of the State of Israel in 1948 and the exodus of Arabs from the endemic foci, a complete change in the character of local schistosomiasis has occurred. During 1948—1950 no new cases of schistosomiasis were registered. In 1951, 19 school children who bathed in the Yarkon River (near its mouth) became infected with *S. mansoni* (Frankl 1953) and in 1955 an outbreak of *S. haematobium* occurred in Tirat Zvi, a settlement in the Beit Shean district.

On the other hand, immigration waves from Asia and Africa brought a large number of chronic infections. It is estimated (Davies and Eliakim, 1955) that by 1953, some 250,000 immigrants came from endemic countries: 50% from Iraq, 18% from Yemen, 18% from Morocco, 10% from Iran. Eliakim and Davies (1954) found by immunological tests the following infection rates in immigrants: from Yemen — 34%, Iraq — 8%, Iran — 6%, Morocco — very few cases. Later investigations by the Government Health authorities established 20% infection with *S. haematobium* in a group of 200 immigrants from Marakesh (Morocco) by urine examination. Heller (1953) estimated that there are 30—40,000 infected immigrants, and at least 12,000 of them excrete *Schistosoma* eggs.

The results from examinations of excreta in a few diagnostic laboratories are summarized in Table I. These numbers do not show the exact prevalence of infection in any community, but they may be regarded as an approximate indication of the proportional distribution of both types of schistosomiasis.

These chronic cases constitute a difficult problem from the medical, social and economic points of view. The situation is aggravated by the immigrants

TABLE I

Distribution of types of schistosomiasis among immigrants from different countries

(after Report, Antimalaria Division, Ministry of Health, Jerusalem, 1954)

Type of infection	Yemen	Iraq	Morocco	Egypt	S. Africa	Tunisia	Iran	Total
S. mansoni	74	—	—	—	1	—	1	76
S. haematobium	10	13	2	2	1	1	—	29
Mixed	2	—	—	—	—	—	—	2
Total	86	13	2	2	2	1	1	107

being dispersed all over the country and by the establishment of new settlements near the breeding places of snail vectors of schistosomiasis, partly through force of circumstances, but occasionally through negligence. Owing to the low standard of hygiene of these immigrants and inadequate conditions of housing, it was feared that they would turn Israel into a hyperendemic focus. This, however, has not happened, although a warning was given in 1955 by an outbreak of schistosomiasis in Tirat Zvi involving some 100 children and indicating that spread, or at least outbreaks, of schistosomiasis are possible.

The most important factor for spreading infection in Israel is at present bathing in the open. It is futile to prevent contact with suspected waters as long as properly constructed and controlled bathing and swimming basins are insufficient. Unfortunately it is just the slightly polluted waters which do not preclude bathing but which favour the multiplication of snails.

The necessity for adequate sanitary conditions and supervision of bathing places is gradually being realized, and future outbreaks of schistosomiasis will probably be rare.

Some occupations obviously facilitate infection, for inst. fishing, fish breeding and antimalaria field work.

5. *The role of the Bulinus snail as vector of parasites of livestock*

The same Bulinus snails which serve as vector of *S. haematobium* have an additional significance as vectors of some trematode parasites of cattle and sheep in Israel. It is known that in Egypt, N. Africa and Sudan, Bulinus is the vector of *S. bovis* and several species of *Paramphistoma*, all being parasites of livestock. These parasites have recently been recorded in Israel (Aharoni 1955, Witenberg 1955), and their ability to develop in local Bulinus snails has been proved by the present authors experimentally. Although no major factor in stock breeding, these parasites have caused losses in several localities (Hadera, Regavim).

II. ECOLOGY AND BIONOMICS OF SNAILS IN NATURAL WATERS

6. *General observations*

In Israel, both Bulinus and Biomphalaria occur under similar ecological conditions. Where they occur together, Bulinus always predominates. Bulinus

seems to be hardier, appears earlier and disappears later than Biomphalaria. Breeding of these snails occurs in several biotopes, and an experienced observer may at once exclude the probability of their presence. However, a favourable biotope does not necessarily mean their presence. Snails are often present only in one of several seemingly identical habitats. Apparently some as yet undetermined factors are decisive in the distribution of Bulinus and Biomphalaria. *Biomphalaria alexandrina,* hitherto found breeding in a single basin of the Yarkon River, requires rather uniform ecological conditions, whilst Bulinus occurs in many places differing somewhat one from the other. In dealing with the ecology of snails, we shall therefore emphasize the manifold habitats of Bulinus.

7. *Characteristics of local water basins and dependence on climatic conditions*

According to Saliternik and Yavor (1955), there exist in Israel 20 rivers running perennially over a total length of about 1,648 km, 568 springs and 257 wadis, besides marshy lands covering an area of about 84,700 dunam *. In addition, there are artificial ponds and pools, about 18,000 irrigation cisterns and wells, and hundreds of canals and ditches.

All local rivers have many common characteristics and ecological conditions, as far as the distribution of snails is concerned. They are mostly small, 3—15 km long and they originate from springs. The flow diminishes gradually during summer and in some of them the current stops before the mouth. Some of them dry up partly and leave stagnant pools maintained by underground water. All rivers drain the rather heavy winter rains. They then swell, sometimes up to four meters above their normal level, and are transformed into torrents during, and for a short time after, the rains. These torrents sweep away all aquatic vegetation to the sea; the rivers contain little vegetation in early spring. All the rivers flowing into the Mediterranean have more or less salty water in their lower parts, although the salt contents fluctuate constantly and quite irregularly, depending on the strength of the winds and the influx of fresh water. Most of the wadis dry up in the greater part of their course during summer, whilst all of them flow intermittently during 3—4 months.

8. *Significance of water bed and current for snail breeding*

Bulinus breeds only in waters with a loamy bottom, and does not occur in places where the bottom is sandy or stony. It lives in stagnant or slowly running water. *A velocity of over 20 cm/sec is unfavourable.* When still water is suddenly put in motion, Bulinus contracts into its shell, expels the air by which it maintains its equilibrium and sinks to the bottom. It then either

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* 1 dunam = ¼ acre.

crawls on the bottom or is carried away with the stream. If the water starts moving slowly the snails may rise to the surface and float. Bulinus snails may occur in swift streams (rivers or ditches), but in such cases they are concentrated along the banks or in their pockets where the current is slow. They may at times be found in swiftly running water but always among thick vegetation (*Ceratophyllum, Cynodon, Panicum,* etc.) which affords them shelter and points of attachment. Banks devoid of vegetation and open to waves are unsuitable for Bulinus.

Large pools and reservoirs with shores subjected to waves and devoid of vegetation are similarly unsuitable for breeding of Bulinus, though the snails may survive in them for some time. In instances, however, when breeding conditions became favourable, sudden breeding of Bulinus may occur. Lake Kinneret and the Kishon reservoir may serve as examples. In spite of numerous searches over years, the authors have not succeeded in finding Bulinus in Lake Kinneret. Yet there was a proof that these snails occur there, for they have been found in the wire-mesh filters of the adjacent fish ponds through which the water pumped from the lake was filtered. Bulinus is, however, constantly present in the mouth of Wadi Rabadiya which opens into Lake Kinneret. At the point of entrance, there is a small bay sheltered by high trees and overgrown with Panicum grass, among which Bulinus was found on several occasions. In 1956 the level of the lake rose and water temporarily flooded about 7 km of the flat northern shore, covering the dense shore grass and depressions. At some points along this stretch, Bulinus appeared (and was readily destroyed by molluscacidal measures).

The Kishon Reservoir is formed by a dam built across the bed of the Kishon River and is filled with water coming from the eastern part of the river which contains breeding places of Bulinus. Snails constantly enter the reservoir, but they have not established breeding places in it, because the bare banks are open to winds and waves, and because of the lack of aquatic vegetation. A few individual snails may occasionally be found hidden between the stones of the dam. Similar phenomena may be observed in the Ta'anakh Reservoir in the same valley.

As pointed out in Chapter 7, winter rains periodically change the character of rivers and wadis in Israel, i. e. denude them of vegetation. The torrents also sweep away most of the snails, so that during the winter many rivers are free of them. It would seem that the rains almost obliterate the snail population ; but, at the end of the rainy season, a few remaining snails reappear, and with the growth of fresh aquatic vegetation, a new breeding season starts.

9. *Tolerance of snails to inorganic matter dissolved in natural waters*

There are, no doubt, limits to the amount of inorganic matter dissolved in water which Bulinus is able to tolerate. Determination of these limits is impor-

tant both for the evaluation of the possibilities of distribution of this snail and, to some extent, to aid in control.

In order to find the limits of tolerance to some of the most common salts, such as chlorides, sulphates and magnesium, chemical tests were carried out on water from natural habitats of Bulinus and on water sources where Bulinus is absent.

It was found that concentrations of these ions in breeding places of Bulinus are so low that salts could not be recognized by taste. In the laboratory, however, it was found that Bulinus can survive in salty water for long periods. Table II shows the highest salt concentrations in natural water in which Bulinus was found to survive, lay eggs, hatch and develop in the laboratory. Most probably there exist some yet unknown factors which decrease the tolerance of Bulinus for these salts.

(a) Chlorides

The highest chloride concentration in which Bulinus was found breeding under natural conditions was 530 p.p.m. in the fish pond of Ein Hanaziv (Beit Shean District), 516 p.p.m. in the drain canal of Kfar Masaryk (near Acre) and 510 p.p.m. in a concrete drain ditch in the vicinity of Beit Shean.

Under some circumstances, both Bulinus and Biomphalaria are apparently able to withstand contact with much stronger salt solutions. This tolerance to salt apparently depends on the length of contact. Thus, for instance, in most spots of the Yarkon River where Bulinus and Biomphalaria are constantly found, chloride content averages 200 p.p.m. When, however, strong winds blow from the west, sea water is forced into the river and may penetrate several kilometres upstream. The chloride content then rises temporarily up to 1,000 p.p.m. Similar conditions prevail in some other rivers in Israel (see also footnote **).

(b) Magnesium

Magnesium occurs in all natural waters in Israel, mainly as $MgSO_4$. The highest magnesium solution in which Bulinus was found in nature was 96

TABLE II

Inorganic material content (p.p.m.) of some spring water samples in which Bulinus was breeding in the laboratory *

	Sahne spring **	Assi Spring	Wadi Balah	Umm Amoud
Cl^-	1,140	990	937	675
SO_4^{--}	100	82	120	119
M_g^{++}	91	74	127	85

* Snails were kept in 3-litre jars filled with water taken from natural sources and supplied with *Ceratophyllum* branches. Water was not changed during the observation period of 3 months.

** During several years' observations Bulinus breeding was never seen in this spring. In April 1957, breeding was unexpectedly established.

p.p.m. (in a ditch near Kfar Masaryk). In most breeding places the magnesium content was nearly 40 p.p.m.

(c) Sulphates

The highest sulphate content in which Bulinus was found breeding under natural conditions was 300 p.p.m. The average, however, is approximately 40 p.p.m. High concentration of sulphate ions apparently has no harmful effects on Bulinus.

10. Requirements in organic matter in natural waters

Since Bulinus can thrive in clear tap water, it would seem that it should be found in some springs or pools where the quality of water is similar to that of tap water, with constant and suitable temperature. Yet in spite of diligent searches, the authors never found Bulinus or Biomphalaria in clear spring water, even if it contained aquatic vegetation and many snails of the genera *Melanopsis* and *Theodoxus,* which breed well in such waters. It is remarkable, however, that jars filled with water from such sources and supplied with plants offered excellent conditions for the breeding of Bulinus. It might be that insufficient oxygen and lack of dissolved organic matter (and hence microorganisms) in springs prevent breeding.

Although organic matter is necessary for the growth of Bulinus, excess introduction of municipal and industrial wastes may cause total disappearance of Bulinus, whilst other species still persist (see Chapter 26/17).

A typical swamp biotope is apparently unsuitable for the breeding of Bulinus. This snail may breed in ditches entering the swamp or in some small pools in its midst, and rarely may a few individuals be found among the typical semi-aquatic vegetation. The high content of dissolved organic matter, resulting from decomposed plants, is apparently unsuitable for Bulinus. This is probably the reason that this snail did not breed in the vast papyrus swamp of Huleh or Kabara or in many other places with seemingly suitable perennial still water.

11. Feeding and relation to vegetation

Bulinus (and Biomphalaria) are active day and night. They incessantly crawl on the bottom, on plants and on various objects immersed in water, scraping their surface with the radule and swallowing the scrapings rich in vegetable and animal micro-organisms and organic debris. They also eat all kinds of decaying plants, such as fallen leaves, banana stems or surface of rotting wood or some particular living plants. On the latter they are usually attracted by parts showing decay ; they eventually make small and medium-sized holes, but they seldom devour the whole plant. They do not eat the hard cellulose veins of plants, but leave them in the form of fine mesh after having eaten away the

soft parts, such as decayed Eucalyptus leaves. Bulinus also eats organic refuse, such as animal excrements, if it comes across them in water.

The main host plant of Bulinus and Biomphalaria in Israel is the deciduous *Potamogeton nodosus.* It grows in both stagnant and slowly running water, is anchored to the water bed and its thin and soft stem, carrying a few oval leaves, rises to the surface. Its length depends on the depth of the water and waries between 10 cm and 1.5 m. It sprouts in March from overwintered roots. In April—June, its leaves reach the water surface and sometimes cover it with an almost uninterrupted layer. In August, yellow patches appear on the green leaves, but in October they turn green again for a few weeks. The plant disappears with the start of the rainy season.

Next in importance is the omnipresent Eucalyptus tree. It grows luxuriantly near the water and promotes the breeding of Bulinus both by obstructing the wind, hence diminishing the waves, and by furnishing excellent food and objects for egg laying in the form of fallen leaves.

Apart from food, Bulinus needs some particular plants for shelter, aeration and oviposition. Bulinus cannot settle in places devoid of vegetation, either aquatic or shore plants. In water basins with few plants, the latter often concentrate most of the snails. Some plants serve as shelters and food, mainly *Potamogeton nodosum* and *Nuphar luteum* (*Eichhornia crassiceps* which was once common does not occur any longer). Others, mainly *Ceratophyllum demersum, Nitella translucens* and *Potamogeton pectinatum,* serve as aerators and are climbed occasionally. Some plants serve as food and shelter, mainly from waves or current, such as *Cynodon dactylon* and *Panicum* spp. which grow on the shores. On the other hand, there are plants which are usually avoided by Bulinus, i. e. the common reed *Phragmites communis, Polygonum senegalense, P. scabrum.* Only under exceptional conditions of crowding or predominance of these plants will Bulinus crawl on them and even lay eggs on them or eat their decayed parts. Duck-weed (*Lemna*) and hair-algae (as for instance *Spirogyra*) are eaten by Bulinus.

12. *Temperature, light and pH requirement*

Activity of Bulinus snails was observed at a temperature range of 10—28°C though they may live for some time in somewhat lower temperatures. Egg laying was observed under laboratory conditions when the day temperature fluctuated between 11°C and 16°C. Optimum temperature is about 25°C.

Under natural conditions Bulinus chooses the undersurface of leaves near the surface of the water. They often crawl in numbers on the shallow bottom exposed to sun light, apparently avoiding the heat but not the light.

The *p*H in breeding places of Bulinus is usually 7.2—7.8.

13. Fertility

Both Bulinus and Biomphalaria have a life span of about $1\frac{1}{2}$ years. Under favourable conditions they reach maturity in about 6 weeks but at times they start egg laying as late as in the 4th month of their life. Bulinus lay egg clutches appearing as flat oval packets of 5—20 eggs arranged in one layer, glued together with a yellowish jelly. An individual Bulinus may lay up to 50 egg clutches during its life. The fertility of Bulinus varies greatly. Biomphalaria lays on the average 5 similar egg clutches during its lifetime, each containing up to 30 eggs. Bulinus lays eggs mostly in spring and in autumn, though egg laying may continue with varying frequency throughout the year. No regularity in egg laying in Bulinus could be established by the present authors. Under laboratory conditions sometimes prolonged egg-laying was going in one jar whilst there was none or only slight activity in other jars. Bulinus may live in a jar for weeks without a single egg clutch, but suddenly start frequent egg laying on transfer to another jar, or if the water is changed or fresh plants are added or when the temperature changes. Egg laying in these cases continued for several days to 3 months. Bulinus and Biomphalaria lay eggs mostly on stems and undersurface of leaves of living plants. In the absence of the latter, for instance in early spring, they would lay eggs on decaying plants, on fallen leaves, tree branches or even on pieces of paper (Figure 15), and in the laboratory on the inner side of jars. They seldom deposit eggs on the hard surface of the bottom of their habitat. The authors observed up to 10 egg clutches on a single decaying Eucalyptus leaf (about 4 egg clutches per cm^2). Under laboratory conditions (25°C) the eggs hatch after 10—14 days. Hatching of eggs of an individual egg clutch may last 48 hours.

Although eggs are laid on many objects, those which adhere to living stationary plants have the greatest chances of survival. Abundance of suitable plants is necessary for the multiplication of the snail in nature.

14. Snail population

Only part of the hatched snails attains maturity. In spite of depletion by enemies and adverse environmental conditions, a snail population starting with a few specimens which survived from the past season, may reach large numbers at the end of one summer. In some instances the authors observed a density of population showing 10 snails per 100 cm^2, crawling on the bottom of a slowly running watercourse, and 5—6 specimens on a 7 cm long leaf of *Potamogeton nodosum.*

Bulinus is usually bound to certain foci in which it appears regularly. Once established it remains for years. It sometimes appears in a locality where it was not observed previously. In some instances, this appearance may be explained

by the previous existence of a swamp years ago in this particular spot in which Bulinus persisted unperceived.

In addition various transporting agencies such as fishermen with their nets and other implements may transplant snails, or new irrigation canals may carry them to distant localities. Animals, such as water birds and beetles, etc., may introduce snails or their eggs.

In places where Bulinus escaped drought by burrowing into the soil, the new breeding starts soon ofter the surface has again been covered with water — usually in December (see following chapter).

In basins with unchanged water level, the activity and breeding of Bulinus are continuous, although its density declines in winter, apparently due to lower temperature. In streams which change their character during the winter rains, the appearance and breeding of snails are seasonal, the start depending on the rainfall and on the prevailing temperature. In a typical stream, such as the Yarkon River, breeding may start as late as April, whilst in some years it goes on almost continuously. In some instances only a few snails survive the winter, but in others astonishingly numerous specimens suddenly emerge from their hideouts. After the commencement of breeding the population density gradually increases until the end of August; thence it usually remains stationary up to the end of the season, in spite of intensive egg laying.

As a matter of fact, multiplication of Bulinus (and Biomphalaria) does not correspond to a typical growth curve. Fluctuations in the density of snail populations are large, and it varies from season to season and from year to year. These variations may be dissimilar even in closely neighbouring sites. There are factors in the bionomics of snails which sometimes play a significant role in population dispersal. One of them, a peculiar kind of reaction to any disturbing stimulus, deserves to be stressed. Bulinus, when disturbed, shrinks into its shell, and usually sinks to the bottom. Sometimes it rises to the surface and floats helplessly and is carried away by the current. If the disturbance of snails is widespread, such floating may result in a sudden mass migration of the snails and their subsequent disappearance from places where they were recently abundant or, on the contrary, they may appear equally suddenly in places where they were previously scanty or absent (see also chapters 8 and 25).

Fluctuations in the population density depend not only on climatic or general seasonal ecologic conditions, but often significantly on peculiar local conditions caused by various factors or by the interference of man. These changes may obscure the influence of regular seasonal factors. Cases have been observed when Bulinus disappeared without apparent cause. For instance, at the end of the summer of 1955, Bulinus disappeared from several fish ponds in the Beit Shean district, although they were found there in the spring and in the beginning of summer. Throughout 1953 and 1954, Biomphalaria was very

numerous in the Yarkon River, while in 1955 it was very scarce, out of all proportion to other snail species.

15. *Defence against desiccation*

Bulinus may withstand prolonged periods of dryness, as is known from other countries. When the water in the natural basin evaporates slowly the snails retreat with the water line and concentrate in the remaining pools. When complete evaporation is approaching, the snails burrow into the muddy bottom. If the mud is sufficiently thick, it is possible to see the openings of the burrows and to remove live snails from them (Figure 9). The depth of the burrows apparently depends on the consistency of the mud. We do not know how long and which part of these burrowed snails remain alive, we could observe, however, that in places which were dry during 7 summer months, snails of practically all sizes appeared suddenly after the first rains refilled the pools (for instance, Birket-Ata and Birket-Safra). It may be presumed that many snails do not survive prolonged dryness, especially those infected with cercariae. The survivors appearing in the water start oviposition, and thus multiplication, whenever the temperature is suitable.

When water disappears rapidly, as for instance during the emptying of fish ponds, snails often concentrate in the water left over and die en masse as a result of subsequent desiccation (Figure 10).

16. *Predators and parasites*

The density of snail populations may be influenced to some extent by other animals associated with the same habitat. Many water birds breeding locally, as well as a great number of migrating birds passing through Israel twice yearly, feed on snails. Several fish species feed on snails, and doubtless some Bulinus and Biomphalaria are destroyed by them, especially in carp ponds. It remains to be determined to what extent these factors influence the snail population.

In many local waters lives a sweet-water crab, *Potamon fluviatilis,* which is related to species reputed to be snail destroyers in other countries. This crab also eats snails. In the laboratory it devours many Bulinus snails if there is no other food available. There is no doubt that it also destroys some snails under natural conditions.

In all places where Bulinus or Biomphalaria occur, especially where water plants are dense, larvae of dragonflies (*Odonata*) are common. Observations in the laboratory showed these predators to be capable not only of eating Bulinus snails, but even of crushing their shells in order to reach the body. A larva of *Crocothemis* sp. can destroy six snails per day (Figure 14). In most places larvae of small Zygoptera are abundant; these are able to eat very young

snails. On several occasions, the rearing of snails in the laboratory failed, because a few of these larvae were introduced with some water plants.

All these predators doubtless destroy some snails in natural waters, but we could never attribute to them a serious influence on snail populations. We observed some instances where the abundance of *Odonata* larvae did not prevent an exceptional abundance of Bulinus snails.

In several lots of Bulinus from the Yarkon River we found oligochaets of the genus *Chaetogaster*. These tiny worms sometimes crawled in numbers on the shell and the body of the snails, which seemed altogether unperturbed by their presence. The worms remained on the body when the snail retracted into its shell. The worms snatch infusoria and in some instances also miracidia of *Schistosoma* approaching the snails. When *Chaetogaster* infected snails were put in a jar with uninfected ones, the worms may soon pass to the latter. We also observed *Chaetogaster* swallowing cercariae of *Schistosoma* emerging from the snail. In one instance, a single worm snatched a dozen cercariae within a few minutes. The appearance of *Chaetogaster* on snails was always occasional and unpredictable and did not persist for long periods under laboratory conditions.

III. INTERFERENCE OF MAN IN THE ECOLOGY OF SNAILS

17. *Introduction*

Great efforts have been made in Israel to rationalize the use of existing water resources for drinking, irrigation and fish breeding. At present, 100 million cubic metres of water are used annually (as compared to the 15 million used prior to 1948). The water is pumped from deep wells or from artificial reservoirs or is diverted from streams and distributed through a network of closed pipes, but rarely through open ditches. In agricultural districts, there are very few open drains which are so characteristic of Egypt and other countries with developed artificial irrigation. Domestic and industrial sewage is in most cases diverted to main canals or is discharged directly into running rivers. The organization of water utilization continues and this process will cause considerable changes in the hydrology of Israel in the near future.

18. *Storage reservoirs, fish ponds and swimming pools*

As stated above, large water reservoirs with banks open to winds and subjected to waves, and reservoirs with frequently and rapidly changing water levels, are not suitable habitats for Bulinus and Biomphalaria. Small water basins, especially those overgrown with aquatic or bank vegetation, are suitable for the breeding of these snails. In rare instances big reservoirs such as the reservoir of Regavim in the Shomron and the Taanakh reservoir in the Esdraelon Valley may harbour Bulinus snails in a few sheltered spots. Some reservoirs are

frequently emptied for irrigation, and thus, are unsuitable for Bulinus. Others contain water for long periods and, if neglected, aquatic vegetation is liable to develop and create conditions favourable for Bulinus breeding. In particular cases such neglected pools may become a schistosomiasis focus for a wide area (Tirat Zvi, 1955).

Fish breeding constitutes a widespread and important branch of local agriculture in all flat parts of the country. Fish ponds occupy at present some 38,000 dunams *. Those kept in good order, i.e. without inlets, with uniformly deep water free of aquatic and bank vegetation, are not suitable for the breeding of snails. On the other hand, badly built ponds with shallow brims overshadowed by the growth of *Panicum* or *Cynodon* grass or containing plants such as *Potamogeton, Nitella* or *Ceratophyllum* may become favourable breeding foci for schistosome vectors. We found Bulinus in such ponds one year after they had been filled with water. Normal management of fish ponds, such as intermittent gradual emptying, introduction of fish food, manure or chemicals (for the destruction of algae or *Prymnesium*), does not seriously influence snail breeding. Once Bulinus is established in one of a group of fish ponds, others are liable to become infested soon through the agency of fish nets or other implements. It follows that if one in a group of fish ponds has been found infected with Bulinus, the whole group under the same management is to be regarded as affected. In the course of this study, the authors observed the gradual spread of Bulinus in groups of fish ponds in Ayanot (near Rehovot), Hadera and Ginossar (Lake Kinneret).

19. *Open canals*

In many rural districts of Israel there are ditches, which may be divided into three categories: (a) irrigation ditches bringing spring or underground water, (b) drains of swamps, agricultural land or seepage from fish ponds, and (c) domestic or industrial sewage canals.

(a) *Irrigation canals and ditches*

Most of the irrigation mains are narrow, up to 1 m wide. They have to carry large quantities of water in a short time. In most cases their banks are cleared of vegetation and sometimes lined with concrete. The flow is generally swift. Side branches are of the same construction but still narrower. They are intermittently empty, as water is usually directed by rotation to one of several side channels. Only those with a deposit of loam and vegetation are liable to become breeding places for snails. As examples of such neglected ditches the following may be quoted: the ditch bringing water from Wadi Bira to the storage pool of Kibbutz Gesher (in the Jordan Valley), the concrete ditch near Reshafim

* About 9,500 acres.

(vicinity of Beit Shean, Figure 5). Generally, irrigation channels seldom proved suitable for snail breeding, but in the course of developing the irrigation system of the country, open water channels may become media for the spread of schistosome vectors or schistosome cercariae or both, from their breeding places to other points, even to those in which they cannot thrive.

(b) *Drains*

Drains are generally less numerous than irrigation channels. They are mostly narrow, flat, overgrown with aquatic and shore vegetation and the flow is slow and continuous. They frequently afford suitable breeding conditions for Bulinus. Drains of seepage from fish ponds are often used during the emptying of the latter. In such instances large quantities of water suddenly rush through them, raising the level and sweeping away plants and also snails for great distances. Cases were observed when not a single snail was found in places where there were many a few days previously. However, almost always a few snails or their eggs remain in the bed of the ditch or among the vegetation and after the current subsides, they start to multiply and the population quickly regenerates.

(c) *Sewage canals*

Undiluted domestic and industrial sewage is a medium unsuitable for Bulinus and Biomphalaria. If the dilution is considerable, the opposite effect may be observed, for a slight addition of organic content may facilitate snail breeding (see also Chapters 10, 26/2). The most dramatic disappearance of snails was observed in the lower part of the Hadera River, after the wastes from a paper mill had been introduced.

It should be noted that human excrements are not harmful or objectionable to Bulinus; we observed these snails avidly clustering around such material in water.

20. *Closed pipe systems*

There are no rains in Israel for almost 7 continuous months, and during the whole of this period water for agricultural needs is pumped from any available source and distributed mainly through a system of pipes. Along these pipes there are numerous taps, valves and plugs sometimes sunk in concrete manholes or other depressions. Water often seeps into these places and if it is not absorbed by the ground, it forms small pools in which some aquatic animals, among them snails, may find suitable breeding conditions. River or swamp water may contain Bulinus snails and they can reach these pools since they pass the pumps unharmed. Examples of such breeding places were found in Afikim (Jordan Valley), Ayanot (near Ness Ziona), near Hadera (Pardess Rutmann) etc. (Figure 11). It appears that a closed water system may promote the spread of Bulinus if it is not kept in good order.

21. *Alternation of water courses*

Although occasional or periodical drying of basins, in which Bulinus snails find suitable breeding conditions, does not ensure their destruction, we observed that frequent intermittent drying may cause a reduction in their numbers and even their disappearance. As an example we mention a segment of the Kishon River (crossing the road near Afula), in which Bulinus had formerly been breeding intensively. After a supplementary bed was dug to fill the Taanakh reservoir, and the water was directed to it in intervals, breeding of Bulinus in the old bed almost ceased.

22. *Ritual bathing places*

It is important to draw attention to the custom of some oriental communities to build small basins for ritual bathing (Mikvot). These are often constructed in the open by widening small streams in wadis, near springs, etc. (Figure 12). Under suitable conditions (overgrowth by plants or general neglect) they may possibly become suitable for snail breeding and, thus, turn into foci of infection. Up to the present we have found such mikvot in the hilly country and none of them contained either Biomphalaria or Bulinus, but the sanitary authorities would be well advised to keep them under observation.

23. *Introduction and destruction of vegetation*

We have seen that man can significantly change the ecological conditions of snails through interfence with vegetation. Generally, the removal of plants results in less favourable conditions for snails, but under certain circumstances the reverse may follow. For instance, by removing reeds which are avoided by Bulinus, the area thus treated often becomes covered with *Potamogeton* or other plants which create favourable conditions for this snail. Introduction of new plants, too, may change the ecological conditions to the advantage of Bulinus and Biomphalaria which may increase in unprecedented numbers. We witnessed an impressive example of ecological influence through introduction of a new plant. In 1954 a foreign plant, water-hyacinth (*Eichhornia crasciceps*), suddenly appeared in the Yarkon River, introduced by some unknown person. This plant, hitherto unknown in this country, found excellent growth conditions in the sewage waters and rapidly spread in both directions. A year later it turned out to be a menace, as it overgrew the surface of a 30 metres wide river and interfered with communications (Figure 13). But the most important consequence of this invasion was an unprecedented breeding of snails, among them both Bulinus and Biomphalaria which found excellent breeding conditions in the luscious thickets. The imminent danger was later eliminated by a campaign of uprooting and destruction of all plants, which will be described in another paper.

IV. GEOGRAPHICAL DISTRIBUTION OF BULINUS AND BIOMPHALARIA IN ISRAEL

24. Methods

In order to determine the distribution of breeding places of Bulinus and Biomphalaria in Israel, the authors examined all places in which breeding seemed possible *. Many established breeding places were visited at frequent intervals in order to follow seasonal changes in breeding intensity. The examinations were made either from the shore or from the boat (motor boat whenever possible), but invariably with the help of a scooping net. The presence of snails was ascertained by direct findings.

(a) Net

A useful type of wire net for scooping molluscs from water was developed after numerous trials (Figure 16). The frame has a trapezoidal shape of about 25 cm in each direction. It is made of a flattened brass pipe 1 cm wide into which 2 mm thick steel wire was inserted before flattening, both ends being fastened into a 10 cm long and $2\frac{1}{2}$ cm wide brass handle. At the end of the handle there is a screw surrounded by a strong ring. The base of the net is reinforced by a brass plate *(d)*. The net, 7 cm deep, is made of galvanized netting No.14. This net is strong enough to withstand rough handling on removal of snails from the bottom of the water basin or from dense plants.

(b) Traps

A number of investigators have proposed the use of traps in order to establish the presence or the density of snail populations. Egyptian workers (Greamy 1952, Stefenson 1947, Abdel Azim 1948, et al.) are satisfied with the use of palm leaves. In their opinion palm leaves possess a strong attraction for snails and, if left for several days in suspected waters, will bait snails even when few are present. Markowsky (1955) even devised a barrier trap based on the attractiveness of palm leaves for Bulinus. We tried to use date palm leaves for this purpose, but did not obtain satisfactory results. Palm leaves proved less attractive than *Potamogeton* or other native plants which are present wherever Bulinus occurs. Apparently the ubiquity of suitable plants and the peculiar physical properties of local water make palm leaves less suitable as a bait in this country than in Egypt. We tried, therefore, several types of metal or wooden traps into which *Potamogeton* leaves, *Ficus* leaves, lettuce or Standen's food was put (Figure 17). Experiments with these traps were made on several sites on the Yarkon and at various depths. Experience has shown that the number of snails entering these traps is not larger than those climbing on plants growing in the vicinity. Our experience indicates that

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Bulinus does not respond to such food stimuli as we were able to use and is not attracted at a distance by the most preferred food. In nature it crawls blindly until it encounters suitable food. If the density of snails is great, they would concentrate on any bait, but where they are widely dispersed, only a few have a chance to be attracted. The authors decided, therefore, that the use of traps for determining the presence or density of snail poplations is impracticable in local conditions.

25. *General observations*

Although both schistosomiasis vectors, *Bulinus truncatus* and *Biomphalaria alexandrina,* require an apparently similar ecological background, they occur together only in the Yarkon River, whilst in all other foci Bulinus is found alone. We shall, therefore, restrict ourselves to Bulinus in the following pages. Bulinus is to be found in many stagnant or slowly running waters in the lower regions of the northern and central parts of the country. It was not generally found in hilly country, the Negev and the Arava Valley.

The absence of Bulinus in hilly country may be explained by the scarcity of swamps and absence of rivers. In most cases water flows swiftly on stone or gravel beds and is overshadowed by dense vertical vegetation. It should be pointed out that elevation alone is no obstacle to the breeding of Bulinus. Thus, for instance, Bulinus was found by Sarnelli (1934) at a height of 3,000 m in Sanaa (Yemen), and Kuntz (1954) found Biomphalaria in the same locality. It is to be expected that with the erection of planned dams and reservoirs in the hills, suitable conditions for Bulinus breeding will be created there.

As for the Negev and the Arava Valley, these districts are poor in perennial water basins and the spring water usually has a high salt content. It is probable that with the completion of planned irrigation projects conditions for Bulinus breeding may be created at some points.

Even in districts where Bulinus occurs, its presence is limited to certain basins and sections of streams. This does not mean that breeding places are permanent; on the contrary, they appear in points where they were previously unknown and may disappear without apparent cause from points in which they were known to breed in the past.

The distribution of breeding places of Bulinus does not necessarily correspond to the presence of apparently suitable ecological biotopes. Bulinus sometimes abounds in a ditch or a wadi and is absent from seemingly identical sites in the vicinity. Even in a pond or stream in which Bulinus occurs, its local distribution is often most uneven.

Biomphalaria alexandrina was found in Israel only in restricted parts of the Yarkon River, where it sometimes breeds in great numbers. While there is

no explanation for the restriction in distribution to this particular water basin, a presumption may be advanced for the concentration in its lowest part. It can often be observed that when disturbed, Biomphalaria tends to detach itself from the plant and to rise to the surface. If this happens in the stream, the snail is carried away and reaches the shore at some distance, if it is not swept out to the sea. Sometimes dozens of snails may be seen drifting helplessly in the stream (see also Chapters 8,14).

It may be pointed out that in Egypt, where *Biomphalaria* occurs in many places, its distribution is restricted to the lower part of the Nile Delta, where it breeds in stagnant or sluggish irrigation and drainage canals, and also to the upper reaches of the White and Blue Nile (Abdel Azim, 1948).

26. *Examples of habitats of Bulinus*

During recent observations, the authors registered over 80 points where Bulinus may be found, either as transient fauna passively brought by some transporting agency (mainly water current), or breeding as a permanent inhabitant. The characteristics of the most important breeding places are given below, followed by a full list of habitats. Numbers in brackets denote the site on the map.

(a) Huleh (1—7)

In the whole of the Huleh lake and the vast surrounding swamps, Bulinus breeding was unknown until recently. Mr. S. Gal, a teacher in Hulata, a few years ago collected them in a drain from fish ponds near the shore of the swamp, but they have since disappeared. A survey undertaken in 1955 showed the presence of Bulinus in some of the numerous fish ponds in the district and in a blind ditch of a drain near Lehavot Habashan. The snails were usually not numerous, and lived among dense growths of *Panicum* and other shore plants. It should be recalled that as long ago as 1913, Preston found a Bulinus shell at the mouth of the Jordan in Lake Kinnereth, which was possibly brought there with water from the Huleh basin.

(b) Ginossar (8)

Near Ginossar (on the northern shore of Lake Kinnereth) there are two groups of fish ponds. One of them belongs to the kibbutz, the other to the Division of Fisheries and serves for breeding *Tilapia*. While no Bulinus was hitherto found in the first group, this snail is firmly entrenched in the second one. A thorough cleaning of one of the ponds caused a significant temporary reduction in the number of snails, but not total eradication.

(c) Beit Shean Valley (18—31) (Figure 5)

This vast district is rich in water which, though having a relatively high salt content, may support Bulinus (see Chapter 9). This snail reached several

fish ponds by unknown ways. On one occasion, Bulinus breeding abundantly in a storage cistern at Tirat Zvi, caused a serious outbreak of schistosomiasis among local children in 1955 (see also Chapter 18). This breeding place has since been cleared.

Close to the township of Beit Shean are several fish ponds from which water seeps constantly. In order to remove the seepage, ditches were dug and a concrete ditch was built to carry away the water. The slope of the latter is insufficient and this results in stagnation of the seepage and the formation of a swamp in which Bulinus breeds profusely. Morever, the concrete ditch is neglected and halffilled with mud. At this site a swamp is formed which constitutes a permanent breeding place for Bulinus. From here the snails may possibly spread over a vast area.

It is not clear what factors prevent Bulinus from spreading in the Beit Shean Valley. It is possible that the chemical properties of the spring water used in the upper part of the valley permit breeding only in particularly favourable conditions which do not exist everywhere.

(d) Leaking valve near Havat Shmuel (14)

This is an example of a breeding place created by faulty irrigation installations. A valve in a 15″ water pipe serving an irrigation system is built in a concrete encasing, the bottom of which sank and formed a depression constantly filled with seeping water. This water is pumped from the adjacent Jordan River. In the puddle thus formed, Bulinus was found to persist for long periods. It disappeared after the valve was repaired.

(e) Jordan River (13—17, 27)

No records exist of the presence of Bulinus in the Jordan River or its tributaries, though its occurrence is feasible, as the Jordan water is suitable for its existence. Apparently because of the swift current and the scarcity of suitable horizontal plants, Bulinus can breed in the stream only in spots where the current is slow or absent. Such a spot was found in the Jordan in 1955, in the vicinity of Kfar Ruppin at a bend where the low bank forms a small inudated area. A subsequent search in October could not, however, reveal them again. Apparently, the snails were carried downstream during a rise in level and an increase in current, which are caused periodically by the operation of locks at the southern shore of Lake Kinnereth.

The river probably receives a constant influx of Bulinus. Individual snails may come from Lake Kinnereth, Wadi Bira (near Kibbutz Gesher) or drains from fish ponds in the Beit Shean Valley. It is not excluded that an influx of Bulinus comes also from the Yarmuk River, which joins the Jordan not far south of Lake Kinnereth, or from the pond at the hydroelectric station at Naharaim in Transjordan.

The presence of Bulinus in the Jordan River was also established indirectly when Bulinus snails were found in two storage cisterns (Beit Yosef and Havat Shifa) and at the leaking valve of an irrigation pipe near Havat Shmuel (see above). All these points are based on water pumped exclusively from the Jordan River.

(f) Gesher (12)

Near Kibbutz Gesher there is a ditch bringing water from Wadi Bira. It is 4 km long and flows swiftly through dense growth of *Panicum*. Intensive breeding was established there in 1955. It is noteworthy that the snails could not establish themselves in the storage cistern into which they were certainly carried by the current, because the cistern is kept clean and free from plants, and the water level is constantly changing.

(g) Swamps and drains of Kfar Massaryk (32, 33) (Figure 6)

A very large swampy area interesected by a network of drainage ditches and emptying into the Naamein River. The main drain is about 3 km long and $\frac{1}{2}$—4 m wide. There is a rich aquatic vegetation in some sections of the banks, among which *Potamogeton nodosum* and *Ceratophyllum demersum* predominate. In the vicinity there is a group of fish ponds and their drains empty into the main drain. Numerous Bulinus are present throughout the year in many ditches and are especially abundant in some sections of the main drain. Snails are also present in some fish ponds.

(h) Ein Hartiyia (40)

Two groups of springs, connected by ditches and small swampy places in the vicinity. Two ditches, some 3 km long, drain their water into the Kishon or into fish ponds. A few Bulinus have been found in the fish ponds and empty shells were once found on the swampy ground.

(i) Kishon River (38, 41, 43, 46—48)

The Kishon has its source in the vicinity of Jenin (on the Arab side of the border) and empties into Haifa Bay. Its length is about 50 km and it receives water from numerous springs and from several tributaries, some of which dry up during the summer. The main bed, too, dries up in many sections and only holes fed by underground water remain. These water holes are often covered with shore and aquatic vegetations. Breeding of Bulinus of varying intensity is evident in some of them every year, in others occasionally. Constant breeding was found in:

— section between Mokebla (opposite Jenin) and the "Kvish Hasargel" (near Megiddo) *(48, 46)*;

— near the entrance to the Kishon reservoir *(43)*;

— near Kiryat Haroshet *(41)*;

— near Jelami — Shaar Haamakim *(38)*;

The lowest part of the Kishon, between Nesher and the sea (7 km) is polluted by industrial wastes and receives the back current from the sea. In midsummer, a salt content of over 2% was registered there. Bulinus breeding was never observed in this sector.

(j) Becker's Well(44) (Figure 7)

This is a well 2 m deep and 2 m wide, in a former swamp opposite Mishmar Ha'emek. It always contains water and is used for watering of cattle. Bulinus is always present. In the wet season when the ditches in the vicinity are inundated, Bulinus also breeds in them. During the periods of inundations this spot is drained to the Kishon River.

(k) Hadera River (55—61)

The Hadera River is a prolongation of Wadi Hadera, which in turn derives from Wadi Forrein and several swamps. Wadi Forrein is a 6 km long ditch draining several side ditches. It is partly overshadowed by reeds and blackberries, but in open places it contains other vegetation and Bulinus snails. Wadi Hadera is a perennial stream of varying width rich in aquatic vegetation. In many places *Potamogeton nodosus* and *Panicum* cover the water surface and Bulinus is numerous at many points. The river proper is about 6 km long and its average width is 10 m. Banks are high, covered with blackberries and other plants and shadowed by Eucalyptus trees. The banks of the lowest part of the river have only reeds.

Four years ago, Bulinus could be found almost on the whole length of the river. Since the erection of a paper mill (about 4 km from the sea) which discharges its wastes into the river, the horizontal vegetation in the affected part is sparse and all snails, including Bulinus, have disappeared. They abound in the upper part of the river which is not affected by the pollution from the paper mill.

(l) Birkat Safra (63)

This is a small area of about 10 dunam ($2\frac{1}{2}$ acres) east of Hadera. It has a swampy character and is submerged during the winter. The underground water almost reaches the surface and 8 small holes dug for watering cattle are nearly continuously filled with water. Bulinus may be found in these holes at any time, provided there is some water above their bottom. When the swamp is submerged, numerous Bulinus may be found everywhere, among grasses and growths of *Nitella*. Numerous snails are also found in the drain removing surplus water from the swamp through Agrobank and Birkat Taz to Birkat Ata (see below). During the summer months, the drain is dry and Birkat Safra is isolated.

(m) Tcherkas swamp (57)

This swamp, adjacent to Gan Shmuel (near Hadera), is partly drained, and partly retains its swampy character. Bulinus breeds in the drain, which is about ½ m wide and 2 km long. It perennially contains slowly running water and is partly overgrown with reeds and other plants. The drain empties into Hadera River.

(n) Birkat Ata (65, 66) (Figures 3, 4)

This is a depression in the vicinity of Hadera, occupying an area of about 0.2 km². In winter it collects rain water drained from the vicinity, i.a. from the swamp Birkat Taz, Birkat Safra, etc. and forms a lake. A week after inundation, numerous Bulinus snails of varying size appear, apparently emerging from the ground where they persisted during about 7 months in an inactive state. During the short period of inundation, a large population of Bulinus develops, which disappears with the drying of the ground in April, when the water is partly pumped away for irrigation and partly dries up. During the summer, the area is cultivated and irrigated by sprinklers.

At the southern edge of Birkat Ata there is a lock controlling the outlet of the drain. The lock is housed in a concrete encasement which forms a small tank always containing water seeping from the drain opening. In this encasement Bulinus snails are found even when the surrounding ground is completly dry.

The drain functions only during the winter when excess water in Birkat Ata is drawn away by a closed concrete canal tranversing sand dunes southwards for about 2 km, to a ditch in the Hefer Plain (Wadi Sumali). This ditch also receives water from several springs and swamps and open into the Alexandron River. It contains water throughout the year and Bulinus breeds along its entire length.

(o) Alexandron River (68)

The river may be divided into three ecologically different parts. The upper part, Wadi Alexandron, dries up during the summer, leaving several water holes fed by underground watter or seepage from irrigated neighbouring plantations. In these water holes specimens of Bulinus of exceptional size were found. The middle part of the river, about 2 km, is polluted by sewage from neighbouring settlements and has a rich horizontal vegetation. A few Bulinus may be found here. The lower part of the river, about 2 km, is subjected to the inflow of sea water. It has few aquatic plants but a thicket of reeds covers its banks. No Bulinus are found in this part of the river.

(p) Wadi Falik (73—74)

This is a swamp of 0.3 km², between Tel Aviv and Nathanya, and cut by a network of drains. The main drain, about 3 km, contains water during the whole year. Some of the side drains dry up during the summer. There is also

a number of fish ponds. Some places are covered by a reed thicket, but in ditches cleared of reed, aquatic vegetation grows profusely and many species of water snails are abundant. Bulinus is found in the main drain, fish ponds and side pools.

On the east side of the swamp there is a large peat field under exploitation. In one place, from which the peat is being removed, a large pool full of aquatic vegetation has been created. In this pool, no Bulinus has hitherto been found.

(q) Wadi Abu Lejja and Wadi Musrara (75, 79)

Both these wadis are tributaries of the Yarkon. Wadi Abu Lejja is about 7 km long, mainly narrow (1 m on the average), and forms a shallow brook flowing perennially between high banks. Two years ago it was one of the richest breeding places of Bulinus which lived in sections not overshadowed by reeds and blackberry up to the point where wastes of numerous factories are emptied into it. When the sewerage of Petah Tikva was connected with the upper end of Abu Lejja, snails disappeared completely.

Wadi Musrara drains a large district and in winter becomes a 15 m wide torrent. In summer only about 2 km of its lower part receive water from springs and flow is sluggish. Two decades ago this part of the Wadi was the most important schistosomiasis focus in the country, in which bred both species of vectors. The wadi has now become the main sewage outlet of Tel Aviv. Its water is dark and opaque, and no snails can live in it.

The present status of these two tributaries is only temporary and when proper sewage disposal will be arranged in the future, they may possibly return to their previous role as breeding places of schistosome vectors.

(r) Yarkon River (76) (Figure 1)

With respect to the distribution of Bulinus and Biomphalaria, the river may be divided into three parts :

— Rosh Ha'ayin springs,
— upper part of the river between Rosh Ha'ayin and the mouth of Wadi Musrara (9 km),
— lower part, between the latter point and the sea (7 km).

Near Rosh Ha'ayin, a comparatively small area of 100 dunam (0.1 km^2) is very rich in springs, the clear water of which collects and forms the cold, transparent stream of the Yarkon. At this place Biomphalaria was found recently only once and in a small number. The upper part of the Yarkon is deep, flowing rapidly between high and steep banks, and it is almost devoid of aquatic plants. Its water becomes opalescent, due to numerous outlets of sewage pipes from the surrounding settlements. Bulinus may be found only in a few side pockets where vertical vegetation can persist. The lower course

D. RECENT BREEDING PLACES OF BULINUS IN ISRAEL

Symbols of the grade of abundance:
- I — a few specimens found once or occasionally
- II — a few snails found whenever water is available
- III — breeding of moderate intensity
- IIII — widespread breeding

Point on the map	Name of place	Grade of abundance	No. of commentary in Chapter 26	Quoted in Chapter
1	Fish pond of Daphne	I	a	
2	Fish pond of Hagoshrim	I	a	
3	Fish pond of Sdeh-Nehemia	I	a	
4	Drain near Amir	I	a	
5	Fish ponds of Sasa	I	a	
6	Fish ponds of Kfar Hanassi	I	a	
7	Blind drain near Lehavoth-Habashan	I	a	
8	Government fish ponds, Ginossar	IIII	b	
9	Wadi Rabadyieh and NW shore of Lake Kinereth	II		8
10	Fish ponds in Afikim	I		
11	Leaking valve in Afikim	I		
12	Irrigation ditch near Gesher	II	f	
13	Storage reservoir in Neveh-Or	I		
14	Leaking valve near Havat-Shmuel	II	d	
15	Storage reservoir, Havat-Shmuel	I		
16	Storage reservoir, Beit--Yoseph	I	e	
17	Storage reservoir, Havat-Deshen	I		
17a	Sahneh spring	I		
18	Fish ponds of Sdeh-Nahum	I	c	
19	Fish ponds of Hefzibah	I	c	
20	Fish ponds of Beit-Alpha	I	c	
21	Fish ponds of Messiloth	I	c	
22	Fish ponds of Reshafim	II	c	
23	Swamp near Beit-Shan	IIII	c	9.a
24	Storage reservoir, Reshafim	II	c	
25	Fish ponds of Shlukhoth	I	c	9.a
26	Fish ponds of Ein-Hanatsif	I	c	
27	Bank of River Jordan	I	c	
28	Storage reservoir, Havath-Shifah	II	c	
29	Fish ponds of Kfar Ruppin	II	c	
30	Storage reservoir of Tirat-Zvi	II	c	
31	Canal Abu-Farage	I		
32	Drains near Kfar Masaryk	IIII	g	9.a
33	Fish ponds of Midghe	III	g	
34	Branch of the old Naamein River	II		
35	Swamp of Kurdani (Zur-Shalom)	I		
36	Fish ponds of Ramat Yohanan	I		
37	Storage reservoir of Hasollim	III		
38	Fish ponds of Shaar-Hamakim	I		
39	Fish ponds of Kfar-Makabi	I		

Point on the map	Name of place	Grade of abundance	No. of commentary in Chapter 26	Quoted in Chapter
40	Ein Hartieh	I	h	
41	Kishon river near Kiryat-Haroshet	II	i	
42	Sewage ditch near Kfar-Barukh	I		
43	Kishon reservoir	II	i	8
44	Becker's well	III	j	
45	Surroundings of Becker's well			
46	Branches of Kishon River crossing the road "Hassargel"	II	i	21
47	Taanakh reservoir	I		
48	Kishon near Mokebla	II		
49	Uyoun-es-Sawar	I		
50	Difla (Kabbara swamp)	I		
51	Wadi-el-Marah	I		
52	Regavim reservoir	III		
53	Wadi Um-Haruz	I		
54	Wadi Zarghanyia	I		
55	Hadera River	IIII	k	
56	Damaira swamp	I		
57	Tcherkas swamp	II	m	
58	Pardess Rutmann	I		
59	Wadi Forein	II	k	
60	Wadi Hedera	IIII	k	
61	Zeita drain	II		
62	Fish ponds of Celinsky-Altmann	II		
63	Birket Safra & Agrobank	IIII	l	15
64	Birkat Taz	II		15
65	Birkat Ata	IIII	n	15
66	Drain between Birkat-Ata and the river Alexandron	II	n	
67	Wadi Sumali	II	n	
68	River Alexandron	I	o	
69	Fish ponds of Ein-Hahoresh	I		
70	Fish ponds of Hagoel	I		
71	Fish ponds of Heruth	I		
72	Wadi Alexandron	II	o	
73	Fish ponds of Yakum	I	p	
74	Falik swamp (Birkat Ramadan)	III	p	
75	Wadi Musrara	?	q	
76	River Yarkon	II	r	
77	Sutitsky swamp	III		
78	Wadi Mir	I		
79	Wadi Abu-Lejja	?	q	
80	River Rubin	II	t	
81	Fish ponds near Ayanoth	III	s	
82	River Lakhish (Sukreir)	II	u	
83	Water holes of Wadi Lakhish	III	u	
84	Wadi Sarar (water holes)	II		

of the river is wide and its water is semi-transparent because of a heavy sewage load; its current is comparatively slow; abundant growth of vertical vegetation (mainly *Potamogeton nodosum*) appears in the early summer all along the banks. This segment was very rich in Bulinus and in some years also in Biomphalaria. Recently, an indusrial establishment started to introduce a great quantity of sea water at a point about 5 km from the mouth, after being used for cooling the engines. This almost exterminated the snail population along the whole affected part of the stream.

(s) Fish ponds near Ayanot (81) (Figure 8)

Adjacent to the Ayanot agricultural school near Ness Ziona, there is, on a former swamp, a group of fish ponds belonging to settlers of Beit Hanan. Three years ago, a few Bulinus were found in a hole at a leaking lock of an irrigation pipe and in a drainage ditch. Gradually, Bulinus spread along the ponds and now breeds in the dense growth of Panicum on the banks and in the drainage ditches. The drains of this place open into the Rubin River.

(t) Rubin River (80)

Its length is about 10 km. It starts from several perennial water holes and its terminal part is surrounded by an extensive swamp. At present, practically the whole river is covered with thick reed. Bulinus may be found in a few points between the reeds, where horizontal vegetation develops, but it is absent from the surrounding swamp, even at the height of the season when other snails abound.

(u) Lakhish (Sukreir) River (82—83) (Figure 2)

The Lakhish River, together with its upper part (Wadi Burshein), flows for 18 km. During the winter, it drains a large district and its current is swift. During the summer, almost the entire wadi dries up, leaving a number of large and small pools fed by underground water. Some of these pools become covered with reed thickets, in others a dense growth of *Potamogeton nodosum, P. pectinatus* and *Nitella translucida* often almost fills these pools. Bulinus is often found in large numbers in such pools. The river proper, about 3 km, is wide and deep and rich in vertical and horizontal vegetation. Bulinus occurs up to about 1 km from the river mouth, the influx of sea water apparently not allowing it to spread further.

V. TESTING THE INFECTIVITY OF LOCAL SNAILS

27. *Introduction*

It has been established (Files and Cram, 1949) that in some regions, local schistosome races are adapted to local snail races in which they give higher infection rates than in snails serving as vectors in other regions. This pheno-

menon suggests that the introduction of schistosome races to a new locality need not necessarily initiate the spread of schistosomiasis.

On the theory that the infectivity of a miracidium for a strain of *Bulinus* depends on genetic factors (on the schistosome or the snail or both), there is always the possibility of mutations in the trematode or in the snail which may influence the infectivity unfavourably for the hygienist.

The authors carried out some experiments in order to establish whether local races of snails may serve as vectors of schistosome races introduced by immigrants. In order to ensure a supply of miracidia, the authors maintained Schistosoma in the laboratory in Syrian hamsters.

28. *Infection of hamsters*

As a source of Schistosoma eggs, the authors used the liver and intestines of infected hamsters. This animal was chosen because it generally does not pass schistosome eggs in the faeces, but accumulates them in the infected organs. The latter were minced in a Waring blender, concentrated by centrifugation in 1% saline and incubated under a desk lamp in tap water.

The hamsters were infected in narrow glass containers in which they "stood" to half of their height in tap water containing 50—80 cercariae collected from several snails. The containers were closed by a wire net. Before putting the animals into the container, they were cleaned of excrements by being allowed to wade in shallow water for a few minutes. The exposure time was $\frac{1}{2}$—1 hour. It was found that a larger number of cercariae than indicated above often caused death of the animals 4—6 weeks after exposure, i. e. before they accumulated a sufficient number of parasite eggs in their organs. Hamsters infected with Schistosoma usually did not show symptoms of infection, though they died of it after a few months. Ova of the parasite first appeared in the liver of hamsters five weeks after exposure to cercariae. The optimum supply of eggs occurs three months after exposure.

Hamsters infected with *S. mansoni* mostly survived 2—5 months, whilst only a few lived as long as 10 months. On the average 85% of them became infected.

About 73% of the hamsters became infected with *S. haematobium*. The number of recovered worms was smaller than in the case of *S. mansoni* infection.

29. *Snail rearing*

Snails were reared in glass tanks 40×60 cm filled with tap water and supplied with plants, mostly *Ceratophyllum*, which serves as an aerator and is not consumed by snails. Other plants, such as *Potamogeton nodosum, Ludwigia*, etc., were soon eaten and had to be replaced frequently. As food served lettuce leaves or Standen's food (1951), in which powdered lettuce was substituted by

powdered stems and leaves of *Potamogeton nodosum*. The food was allocated in daily rations in order to prevent decay. Experience showed that some foodstuffs, particularly the thick part of lettuce or water lily, caused alcoholic fermentation and killed the snails, when left in the tank for several days. In most cases the tanks became stabilized and could be kept without change of water for months. A layer of fine sand was usually added in sufficient quantity to cover the bottom. Snails used in experiments were kept in similar conditions in 3—4-litre jars. All these vessels were kept in an incubator room at 25°C under constant light of fluorescent lamps.

Sometimes, blue algae *(Cyanophyceae)* developed to such an extent that they covered the bottom and walls of the vessels and the water plants. They interfered with the development of the snails and at times caused a mortality of 100%. Generally, Bulinus proved less sensitive to unfavourable conditions than Biomphalaria, and lived and multiplied in water in which organic matter decayed. If left to themselves, both Bulinus and Biomphalaria would lay eggs on stems or leaves of water plants or on the wall of the container, but from such eggs usually few young are obtained. Therefore, on the advice of Standen (1951), the authors used egg traps in the form of individual leaves of *Potamogeton nodosus*. The snails laid eggs in preference on the undersurface of these leaves, which were put into separate jars until the young reached a size of 2—3 mm. These young snails were removed to large stock tanks.

Both Bulinus and Biomphalaria lived in the laboratory up to 1½ years. During this time *Biomphalaria alexandrina* attained the length of 18 mm, a size which was never observed in nature. Bulinus, on the contrary, rarely reached the size observed under some favourable natural conditions.

In the aquarium, Bulinus usually remains in the water, whilst Biomphalaria tends to crawl out of the water when it feels uncomfortable, in which case it often becomes desiccated and dies. It is, therefore, necessary to push such snails back into the water. No emergence of snails from water was ever observed by the authors in natural conditions.

30. *Infection of snails*

There is a controversy as to the susceptibility of Bulinus infection by *S. haematobium*. Moore et al. (1953) in a review show that in most cases only a small percentage of snails could successfully be infected. Most authors stress the irregularity of artificial infection, which is generally low. The best results were obtained by Brumpt and Werblunsky (1928) who succeeded in obtaining 85% of infected Bulinus. It is difficult to judge which factors are responsible for this discrepancy. Some investigators assert that the result of infection may be enhanced by keeping the infected snails at 26—32°C and by using very young snails (Moore et al. 1953).

For the infection of snails, the present authors used in their experiments miracidia within three hours after hatching. The infection took place in 1″×3″ vials half filled with tap water. Laboratory bred snails were used. Each snail was usually infected individually by 5—10 miracidia, depending on its size. The cercariae appeared 5—8 weeks after infection.

We employed only one strain of *S. mansoni* obtained from an immigrant from Yemen. It was maintained in Syrian hamsters and propagated by a strain of *Biomphalaria glabrata* kindly supplied by Dr. O. D. Standen from London. In this snail the infection rate is approximately 40%. The same strain showed an infection rate of only 17% in local *Biomphalaria alexandrina*.

We tried four strains of *S. haematobium* obtained from immigrants from Yemen, Iraq, Egypt and Morocco. Both the Moroccan and Yemen strains did not infect a single snail out of about 100 exposed to cercariae. The Iraqi strain showed 4%, the Egyptian strains 30% average infection rates in various batches, the highest being in very young snails. In cases of low infection results most of the snails died before the shedding of cercariae could start.

VI. DISCUSSION

In view of the ubiquity of schistosome vectors and schistosome carriers in Israel, the rarity of new infections is remarkable. This discrepancy is, however, only apparent, as not all the factors in the epidemiological chain occur simultaneously in this country.

Although Bulinus is found in many foci in Israel, human carriers of *S. haematobium* are rare. They were never numerous and the majority were cured after diagnosis. Furthermore, the local strain of Bulinus is a poor vector of the strain of *S. haematobium* brought by immigrants.

A similar lack of coincidence of basic epidemiological factors exists in the case of *S. mansoni* infection. Human carriers of this schistosome species are common and dispersed all over the country, but the distribution of its snail-vectors is limited to a restricted part of a single watercourse which is not used for bathing.

In semi-arid countries, the contact of man with cercariae infested water during artificial irrigation constitutes an important contributing factor in the spread of schistosomiasis. In Israel, this factor is unimportant, because irrigation water is distributed mainly in pipes and very often pumped from deep wells and springs free from snails.

On the other hand, fish ponds constitute a difficult problem. They are often built on sites of former swamps and in spite of constant clearing work, they cannot always be freed from the obstinate swamp vegetation.

The present state of the epidemiology of schistosomiasis in Israel must not be regarded as static. Changes in epidemiological factors may occur in the

future, and the possibility of spreading infection may increase. Precautionary measures, especially in relation to water utilization and conservation, should therefore be made routine.

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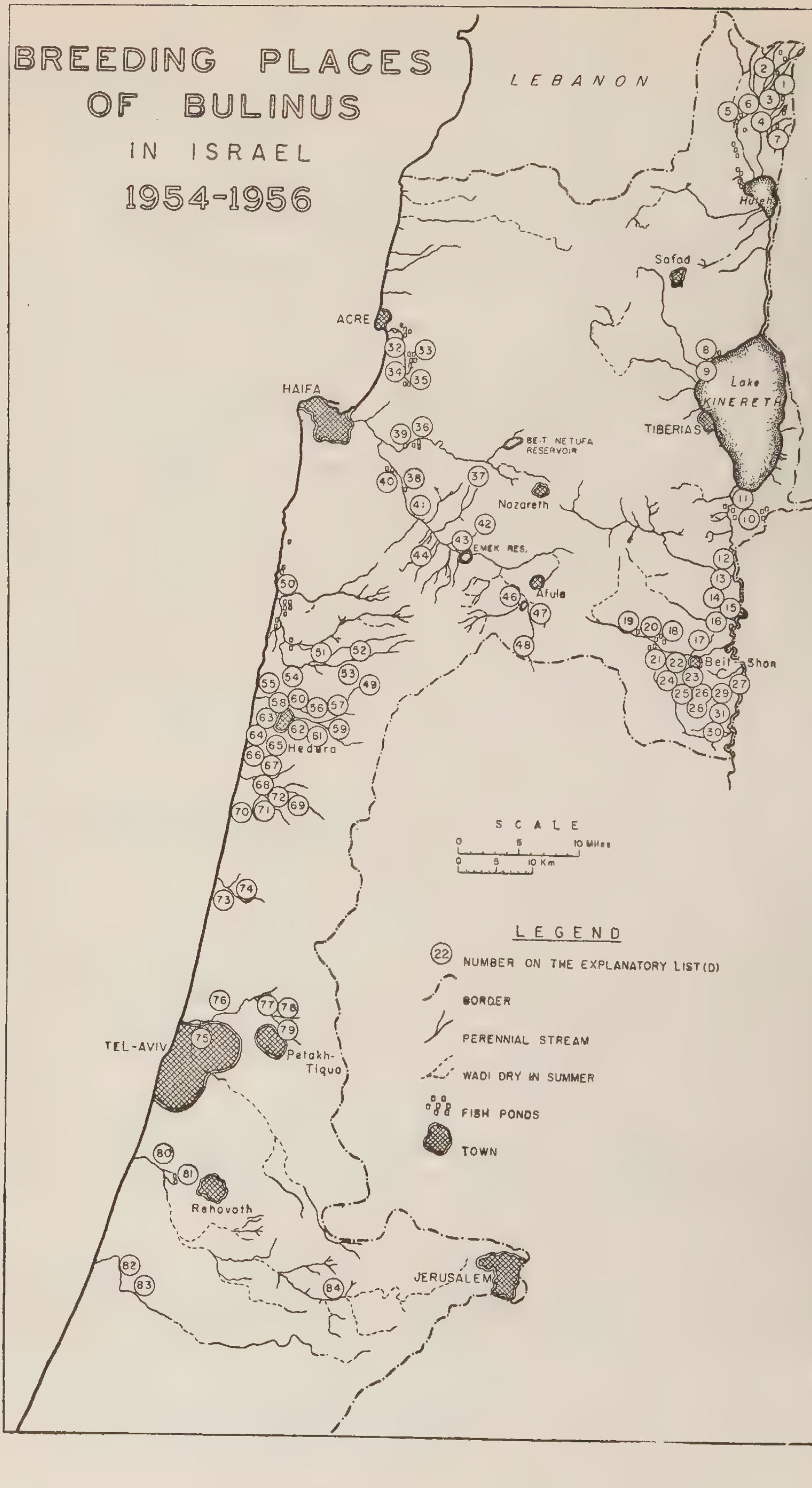
BREEDING PLACES
OF BULINUS
IN ISRAEL
1954-1956
LEBANON
Huleh
Safad
ACRE
HAIFA
Lake KINERETH
TIBERIAS
BEIT NETUFA RESERVOIR
Nazareth
EMEK RES.
Afula
Beit-Shan
Hedera
SCALE
0 5 10 Miles
0 5 10 Km
LEGEND
NUMBER ON THE EXPLANATORY LIST (D)
BORDER
PERENNIAL STREAM
WADI DRY IN SUMMER
FISH PONDS
TOWN
TEL-AVIV
Petakh-Tiqua
Rehovoth
JERUSALEM

Figure 1.
Lower part of Yarkon River, Bulinus and Biomphalaria breeding near the banks.

Figure 2.
Water hole in the dry bed of Laskhish River. Bulinus abounds.

Figure 3.
Birkat Ata after the early rains (December).

Figure 4.
Birkat Ata in midsummer.

Figure 6.
Drain canal near Kfar Masaryk; typical Bulinus biotope; *Potamogeton nodosum* covers the water surface.

Figure 5.
Neglected drain near Beit Shean; Bulinus breeding.

Figure 7.
Becker's well, breeding place of Bulinus.

Figure 8.
Penicum growth in fish pond near Ayanot; Bulinus breeding place.

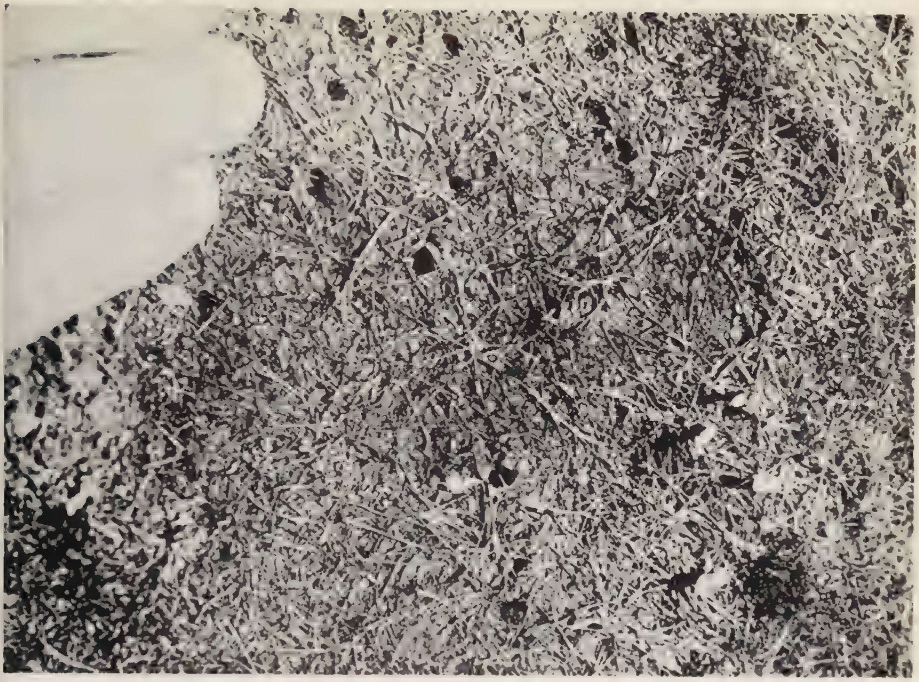

Figure 9.
Burrowing holes of Bulinus in the drying bed of Regavim reservoir.

Figure 10.
Mass of dead Bulinus on bottom of rapidly emptied fish pond in Kfar Ruppin.

Figure 11.
Leaking valve of irrigation pipe near Hadera; Bulinus in puddle.

Figure 12.
Mikva near Tarom.

Figure 13.
Hyacinth growth on Yarkon River; profuse breeding of Bulinus and Biomphalaria.

Figure 14.
Larva of *Crocothemis* sp.
attacking Bulinus.

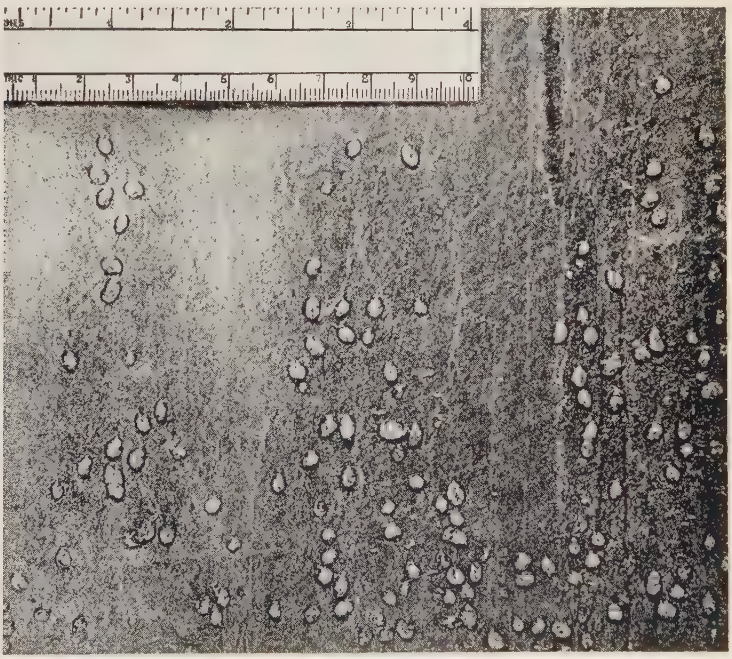

Figure 15.
Egg clutches of Bulinus on piece of cardboard.

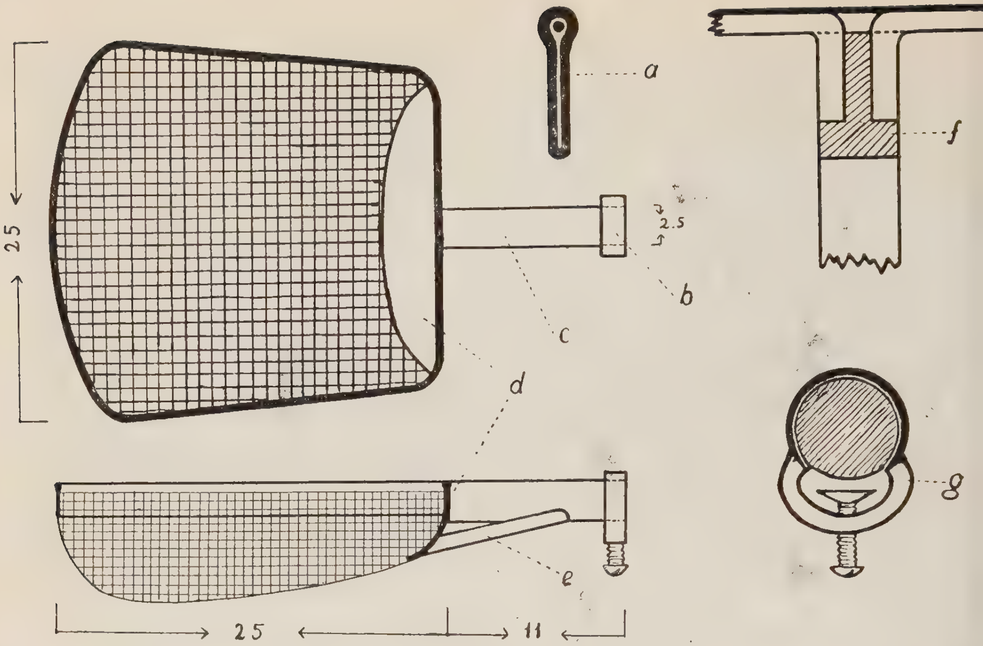

Figure 16.
Details of the snail scop; (a) cross-section of the brass frame, showing the inserted steel wire; (b) rod fastener; (c) handle d) net base (brass plate); (e) handle support; (f) wooden plug keeping the frame end in position; (g) rod fastener (front view

Figure 17.
Two types of the various traps used in detecting Bulinus.

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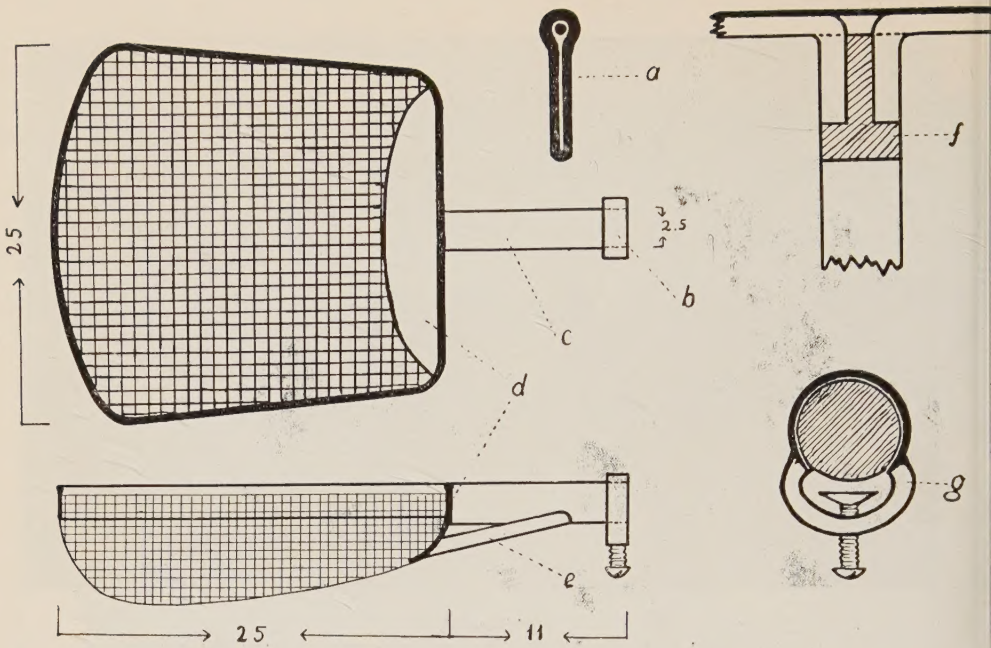

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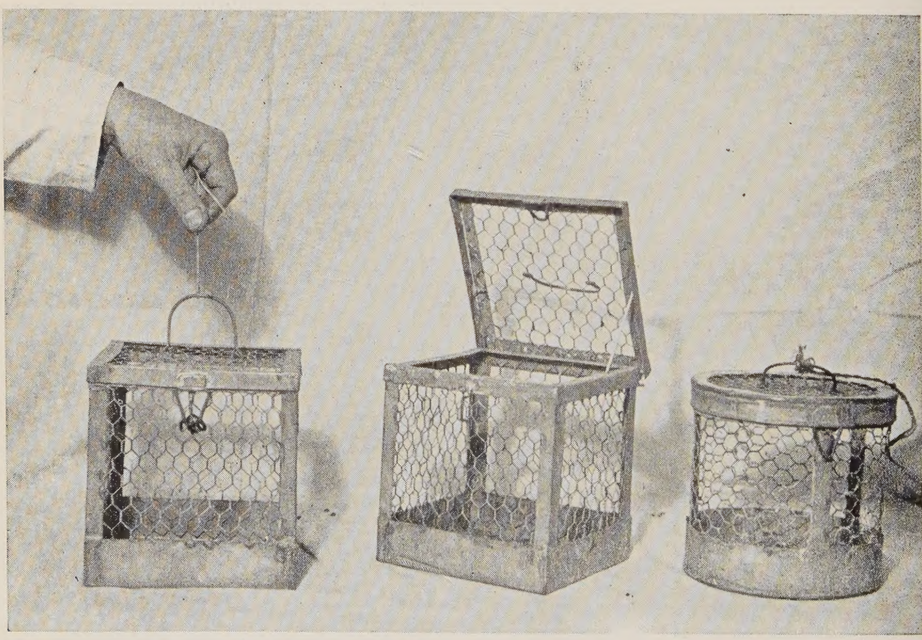

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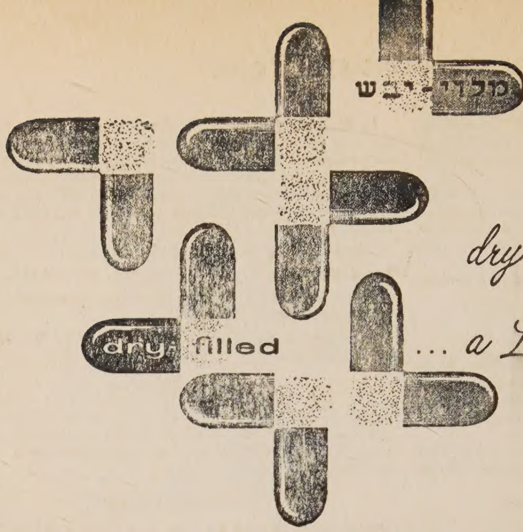

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נוסף על היותן צורת־המינון הנבחרת ברחבי העולם כולו — בתופסן מקום בראש לגבי היעילות של תכשירים אנטיביוטיים רחבי הטווח — מביאות כמוסות **אכרומיצין** לדרלה **עוד יתרון נוסף**: הן ממואלות מלוי יבש. אין בהן שמן, **ולא משחה**; הן עומדות בפני מזיקים; הן נספגות מהר יותר ובאופן מושלם — מבלי לגרום להפרעות בקיבה.

ולשם גמישות קלינית גדולה יותר ניתן להשיג את **האכרומיצין** טטרציקלין לדרלה, התכשיר האנטיביוטי הנפוץ ביותר כיום, גם בצורות־המינון הבאות:

CAPSULES: 50, 100 and 250 mg. / PEDIATRIC DROPS (cherry flavor): 100 mg per cc. (approx. 5 mg. per drop), 10 cc. bottle / INTRAVENOUS: vials of 100, 250 and 500 mg. (institutions and hospitals only) / INTRAMUSCULAR: vial of 100 mg. (limited quantities) / OINTMENT (3%): (Institutions and hospitals only) / OPHTHALMIC OINTMENT (1%): six 1/8 oz. tubes / OPHTHALMIC (for solution): sterilized vial of 25 mg. with sterilized dropper vial.

ספרות ודוגמאות על־פי פניה אל ניאופרם בע״מ רחוב פינסקר 7, תל־אביב, טלפון 24017

Literature and samples upon request from Neopharm Ltd., 7, Pinsker St., T.-A., Tel. 24017.

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